Geostationary Operational Environmental Satellite (GOES)

GOES-R Series

General Interface Requirements Document (GIRD)

Baseline Version

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National Aeronautics and
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1 SCOPE

1.1 Introduction

GIRD3 1.1-1 This General Interface Requirements Document (GIRD) sets forth the general, mechanical, thermal, electrical power, command and data handling and contamination control interface requirements imposed on both the instruments and spacecraft for the Geosynchronous Operational Environmental Satellite (GOES) -R Series System. It also defines the general environments to which the satellite will be subjected. The spacecraft contractor and the instrument contractor shall each meet their respective interface requirements defined in this document.

The Unique Instrument Interface Document (UIID) for an instrument defines the specific resource allocations, documents exceptions to the GIRD requirements and constraints, and defines the special requirements not specifically covered in the GIRD. The instrument contractor will create and maintain, with government approval, an Instrument Descriptive Document (IDD) which describe the detail instrument design and unique interface requirements. The GIRD, in conjunction with the UIID and the IDD establishes the instrument-to-spacecraft interface requirements.

Interface Control Documents (ICDs) will define the specific details of the complete spacecraft to instrument interface information (i.e., mechanical, electrical power, command and data handling, and thermal interfaces). These will be developed by the spacecraft contractor to document the Instrument-Spacecraft interface. The spacecraft contractor will control the ICDs and the ICDs will replace the related IDDs.

1.2 Terminology

1.2-1 The term "(TBD)", which means "to be determined", applied to a missing requirement means that the instrument contractor determines the missing requirement in coordination with the spacecraft contractor.

The term "(TBR)", which means "to be refined/reviewed", means that the requirement is subject to review for appropriateness by both contractors, and subject to revision. The instrument contractor is liable for compliance with the requirement as if the "TBR" notation did not exist. The "TBR" merely provides an indication that the value is more likely to change in a future modification than requirements not accompanied by a "TBR".

An instrument may comprise more than one physical assembly, or unit. "Sensor unit" refers to the unit that contains the optics. "Instrument unit" means the sensor unit, electronics box (if applicable), or other units of the instrument.

1.3 Order of Precedence

GIRD7 1.3-1 The order of precedence of interface requirements documents is the UIID at the highest level, followed in order by the GIRD, ICD, and IDD.

2 Documents

2.1 Applicable Documents

GIRD11 2.1-1 The following documents of the exact issue shown form a part of this GIRD to the extent specified herein. In the event of conflict between the documents referenced and the contents of this GIRD the latter **shall** be the superseding requirement.

MIL-STD-461E Aug 99 Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

ECSS-E-50-12A: Space Wire - Links, Nodes, Routers and Networks, 24 January 2003 European Cooperation for Space Standardization (ECSS)

ISO/DIS 14644-1: Cleanrooms and Associated Controlled Environments, May 1, 1999

CCSDS 701.0-B-3: Recommendations for Advanced Orbiting Systems, Networks and Data Links, Architectural Specification

IEEE/ASTM SI-10: American National Standard for Use of the International System of Units (SI): The Modern Metric System, December 2002

CCSDS 102.0-B-5 Packet Telemetry. Blue Book, Issue 5, November 2000

CCSDS 103.0-B-2 Packet Telemetry Service Specification. Blue Book. Issue 2, June 2001

417-R-RPT-0027: The Radiation Environment for Electronic Devices on GOES-R Series Satellites, March 2004

CCSDS 301.0-B-3: Time Code Formats. Blue Book. Issue 3, January 2002

NASA/TM-2001-211221: Guideline for the Selection of Near-Earth Thermal Environment Parameters for Spacecraft Design, October 2001

417-R-RPT-0050 GOES-R SpaceWire Transport Protocol

2.2 Reference Documents

2.2-1 Spacecraft Attitude Determination and Control, edited by James R. Wertz (Boston: Reidel, 1978), pp. 268-270.

Farrenkopf, R. L., "Analytic Steady-State Accuracy Solutions for Two Common Spacecraft Attitude Estimators," Journal of Guidance and Control (Reston, VA: American Institute of Aeronautics and Astronautics), July-August, 1978, Vol. 1, No. 4, pp. 282-284.

Markley, F. Landis, and R. G. Reynolds, "Analytic Steady-State Accuracy of a Spacecraft Attitude Estimator," Journal of Guidance, Control, and Dynamics (Reston, VA: American Institute of Aeronautics and Astronautics), November-December, 2000, Vol. 23, No.6, pp. 1065-1067.

3 Requirements

3.1 General Requirements

3.1.1 Instrument Modes

3.1.1.1 Mode Changes External Harm

GIRD19 3.1.1.1-1 The instrument **shall** transition from its current mode to any other mode without harming any other instrument or spacecraft bus component.

3.1.1.2 Power Off Mode

GIRD21 3.1.1.2-1 The Instrument Power OFF Mode **shall** not draw operational power.

3.1.1.3 Instrument Safe Mode

3.1.1.3.1 Instrument Safe Mode Command

GIRD29 3.1.1.3.1-1 The instrument **shall** enter Instrument Safe Mode upon receipt of a safeing command from the spacecraft.

3.1.1.3.2 Instrument Safe Mode Timeout

GIRD31 3.1.1.3.2-1 The instrument **shall** enter Instrument Safe Mode upon the detection of 10 consecutive missing time messages.

3.1.1.4 Survival and Storage Modes

GIRD35 3.1.1.4-1 The spacecraft **shall** provide survival heater power in Survival and Storage modes.

3.1.1.4-2 The instrument **shall** not draw operational power while in Survival and Storage modes.

3.1.2 Operational Concepts

3.1.2.1 Pre-Launch

3.1.2.1-1 The satellite will be transported to the launch site where final vehicle preparations and checkout will be accomplished.

3.1.2.1-2 Final inter-segment and system verification tests will be accomplished prior to launch.

3.1.2.1-3 Instrument testing and inspection to be accomplished at the launch site will be documented in the ICD.

3.1.2.2 Launch and Orbit Raising

3.1.2.2-1 During launch the various spacecraft subsystems may be powered on or turned off in order to provide protection from the launch and injection environments or to comply with other specified requirements. Spacecraft telemetry to monitor vehicle status may be provided during launch. Transmission of launch vehicle telemetry may satisfy this requirement during the launch phase. During the Orbit Raising and after insertion into its operational orbit, appropriate deployments would be initiated by command. Spacecraft telemetry transmission to ground monitoring stations would be used to the extent practicable.

3.1.2.2-2 The instrument will be in Survival Mode during launch.

3.1.2.2-3 The instrument contractor will identify in the IDD the required configuration of the instrument for the launch environment, and the power required, in the event the mode is to be anything other than OFF, and also to document required sequences leading up to the pre-launch OFF mode.

3.1.2.3

3.1.2.3 On-Orbit Concept

3.1.2.3-1 The satellite will operate in a geosynchronous orbit (Semi-major axis of approximately 42,164 Km) located at either 75° or 135° west longitude. Normal on-orbit operations entail periodic station keeping maneuvers that keep the satellite within a 0.5° inclination about the equator and within ±0.5° of the on-station longitude.

3.1.2.3-2 The spacecraft will be 3-axis stabilized.

GIRD842 3.1.2.3-3 Instruments **shall** survive an anomaly resulting in a static instrument line-of-sight (LOS) such that the sun passes through the LOS at orbit rate.

GIRD45 3.1.2.3-4 Instruments **shall** survive a spacecraft attitude anomaly resulting in the sun being at an arbitrary fixed location within the instrument field of regard (FOR).

GIRD46 3.1.2.3-5 Instruments **shall** survive a spacecraft attitude anomaly resulting in the sun sweeping through the field-of-view (FOV) of the instrument radiator from "horizon to horizon" at a rate of 6^{O}/minute, passing through radiator normal.

3.1.3 Dimension Standard

GIRD48 3.1.3-1 For all documents related to instrument interfaces, the spacecraft and instrument contractors **shall** use the International System of Units (SI) for all measurement units in accordance with <u>IEEE/ASTM SI-10</u>. The contractor may include English units in parenthesis for clarification.

3.1.4 Coordinates

GIRD52 3.1.4-1 The spacecraft and instrument contractors **shall** use an orbit reference frame (ORF) defined as follows:
The ORF is orthogonal and right-handed.
The ORF origin is at the spacecraft center of mass.
The ORF +z axis points toward the center of the Earth.
The ORF +y axis points along the negative orbit normal.
The ORF +x axis completes the triad.

3.1.4-2 The body reference frame (BRF) is defined as follows:
The BRF is orthogonal and right-handed.
The BRF is fixed to the body of the spacecraft.
The location of the BRF origin will be specified by the spacecraft contractor.
The BRF axes are nominally parallel to the ORF axes when spacecraft attitude is in its nominal Earth-pointing, upright yaw attitude with zero attitude error.
The roll, pitch, and yaw axes are defined to be parallel to the BRF x, y, and z axes, respectively.

3.1.4-3 If there is a yaw-flip, the spacecraft will be flown upright (+Y BRF pointed in the +Y ORF direction) during northern hemisphere winter and inverted (+Y BRF pointed in the -Y ORF direction) during northern hemisphere summer. i.e., the +Y BRF axis is generally in the same hemisphere as the Sun.

3.1.4-4 If there is no yaw-flip, the spacecraft will be flown upright all year.

3.1.4-5 At the option of the government, the spacecraft may be flown such that the BRF is offset from the ORF so that the BRF x-axis is always parallel to the Earth's equator and/or the BRF z-axis always points to the nominal subsatellite point.

GIRD870 3.1.4-6 The reference coordinate system of each instrument unit **shall** be nominally parallel to the spacecraft BRF coordinate system, with the exception of solar-pointing instruments.

GIRD871 3.1.4-7 The origin of the coordinate system of each instrument unit **shall** be located and defined inside the mechanical envelope of the instrument unit.

3.1.5 Yaw Flip

GIRD1136 3.1.5-1 For an instrument with passive cryogenic detector cooling, the GOES spacecraft will be rotated 180^{O} about the Z-axis (yaw) twice per year to keep the -Y axis side of the spacecraft shaded, within ±4 days of the Sun crossing the orbit plane.

GIRD1137 3.1.5-2 The rotation will be performed any time during the 8-day window and will be carried out such that neither the Sun nor Earth illuminates the cooler during the maneuver. The maneuver is expected to last less than 1 hour. The net effect reverses the sign of the roll and pitch axes while maintaining yaw pointing at nadir.

		3.2 Interface Requirements
GIRD931	3.2-1	All instrument-to-spacecraft interfaces **shall** be single fault tolerant.
		3.2.1 Mechanical
		3.2.1.1 Instrument Envelopes
GIRD59	3.2.1.1-1	The instrument units **shall** meet the dimensional envelope constraints defined in the UIID under conditions encountered during launch, deployment, and on-orbit operations.
		3.2.1.1.1 Envelope Documentation
	3.2.1.1.1-1	The instrument contractor will document the instrument unit envelopes in the IDD by engineering drawings with a set of "not to exceed" dimensions. The instrument envelopes will be inclusive of the thermal blankets.
	3.2.1.1.1-2	The instrument contractor will ensure that the swept or deployed volume includes tolerances, distortions and misalignments.
		3.2.1.1.2 Critical Clearances
GIRD65	3.2.1.1.2-1	The satellite **shall** fit within the dynamic envelope of the launch vehicle fairing as described in the satellite-to-launch vehicle ICD.
	3.2.1.1.2-2	The spacecraft contractor will position the instrument units on the spacecraft to ensure that the stowed, deploying, and final deployed positions of the instrument units clear all obstacles including obstacles on the spacecraft, other instruments, and the launch vehicle.
GIRD67	3.2.1.1.2-3	A minimum of 2.5 cm clearance **shall** be maintained between the instrument units and surrounding structure.
	3.2.1.1.2-4	The spacecraft contractor will implement a critical clearance analysis to ensure that the clearance rule is not violated.
GIRD69	3.2.1.1.2-5	The instrument thermal blankets **shall** not impede any deployment or mechanism motion.
		3.2.1.2 Fields of View
GIRD73	3.2.1.2-1	The spacecraft **shall** provide the instrument fields-of-view defined in the UIID.
	3.2.1.2-2	The instrument contractor will document the instrument field-of-view requirements in the IDD.
GIRD77	3.2.1.2-3	Instruments **shall** meet all performance requirements whether or not the spacecraft performs a yaw flip, except for instruments with cryogenic detectors cooled by a passive radiator.
		3.2.1.3 Mass Properties
GIRD79	3.2.1.3-1	The instrument mass **shall** be less than or equal to that allocated in the UIID.
	3.2.1.3-2	The mass of the instrument units will be measured with an accuracy of ±0.5 kg.

GIRD81	3.2.1.3-3	The instrument mass **shall** be constant unless mass expulsion rates and substances are allocated by the UIID.
	3.2.1.3-4	The nominal launch mass with tolerances of each instrument unit will be provided to the spacecraft contractor for documentation in the ICD.

3.2.1.3.1 Center of Mass

	3.2.1.3.1-1	The instrument contractor will determine the centers of mass for each flight instrument unit relative to the instrument unit coordinate system with an accuracy of ± 5 mm including launch and deployed configurations.
	3.2.1.3.1-2	The launch and deployed centers of mass with tolerances of each instrument unit will be provided to the spacecraft contractor for documentation in the ICD, referenced to the instrument coordinate axes.

3.2.1.3.2 Inertia Properties

	3.2.1.3.2-1	The instrument unit moment of inertia will be defined using the instrument unit coordinate frame passing through the instrument center of mass.
	3.2.1.3.2-2	The instrument contractor will determine the moments and products of inertia values with an accuracy of ± 5% of the maximum principal moment of inertia.
	3.2.1.3.2-3	The launch and deployed moments and products of inertia with tolerances of each separately-mounted instrument unit, referenced to the instrument coordinate axes, will be provided to the spacecraft contractor for documentation in the ICD.

3.2.1.4 Mounting

3.2.1.4.1 Hardware

	3.2.1.4.1-1	The spacecraft contractor will define and document all mounting hardware in the ICD and indicate the hardware provider.
	3.2.1.4.1-2	Unless otherwise specified, the spacecraft contractor will provide all mounting hardware for the instrument units.
GIRD100	3.2.1.4.1-3	The instrument sensor unit **shall** mount to the spacecraft as described in the instrument UIID.
	3.2.1.4.1-4	The instrument contractor will provide all kinematic mounts, plus vibration isolation and thermal isolation mounting hardware.
	3.2.1.4.1-5	The instrument units will be delivered to the spacecraft contractor with flight mounts installed.

3.2.1.4.2 Method

GIRD104	3.2.1.4.2-1	The mounting method **shall** accommodate manufacturing tolerances, structural distortion, thermal distortions and alignment requirements.
GIRD105	3.2.1.4.2-2	The instrument units, excluding the sensor unit **shall** be capable of being mounted to the spacecraft with the spacecraft mounting surface in the vertical or in the horizontal position with the spacecraft mounting surface normal pointing up.
GIRD1070	3.2.1.4.2-3	The instrument sensor unit **shall** be capable of being mounted to the

		spacecraft with the spacecraft mounting surface in the horizontal position with the spacecraft mounting surface normal pointing up.
GIRD106	3.2.1.4.2-4	For instrument units with a mass greater than 15 kg, a minimum of three lifting points **shall** be provided.
GIRD107	3.2.1.4.2-5	The design of the lifting points **shall** allow handling with an overhead crane including when the unit is in its flight configuration.
GIRD1056	3.2.1.4.2-6	Each instrument unit design **shall** allow integration and de-integration to the spacecraft while using access constrained to the inside of the instrument dimensional envelope defined in the UIID with access penetrations into this envelope through the face of the envelope that is opposite to the mechanical interface plane.
GIRD109	3.2.1.4.2-7	Each instrument unit mounting method **shall** not require access from inside the spacecraft.
	3.2.1.4.2-8	The method by which each instrument unit is mounted to the spacecraft will be defined in the ICD.
		3.2.1.4.3 Handling Fixtures
	3.2.1.4.3-1	The instrument contractor will provide proof tested handling fixtures for each unit with a mass greater than 15 kg.
GIRD113	3.2.1.4.3-2	Handling fixtures **shall** be designed to 5 times limit load for ultimate and 3 times limit load for yield.
	3.2.1.4.3-3	Handling fixtures will be tested to 2 times working load.
		3.2.1.4.4 Interface
GIRD116	3.2.1.4.4-1	The spacecraft mounting surface **shall** be flat to less than 0.83 mm per meter peak to peak.
	3.2.1.4.4-2	The spacecraft contractor working with the instrument contractor will define the mechanical mounting interface requirements for each instrument unit in the ICD. Requirements include surface flatness, finish, mounting bolt size, number, material, and torque limits.
		3.2.1.4.5 Location
	3.2.1.4.5-1	The spacecraft contractor working with the instrument contractor will define and document the location and orientation of instrument units on the spacecraft in the ICD.
	3.2.1.4.5-2	Coordinates and dimensions of the holes for mounting hardware will be specified at the mechanical interface and defined in the ICD.
		3.2.1.4.6 Drill Templates
GIRD122	3.2.1.4.6-1	The pattern of mounting holes in a unit **shall** allow like units to be interchanged.
GIRD123	3.2.1.4.6-2	Instrument unit, spacecraft, and test fixture interfaces **shall** be drilled using templates to correctly establish the pattern of the mounting holes.
GIRD124	3.2.1.4.6-3	The drill template **shall** include appropriate alignment, orientation and location reference information and alignment cubes if required.
	3.2.1.4.6-4	The spacecraft contractor will document fabrication, functional

requirements, and orientation information for the drill templates in the ICD.

3.2.1.4.6-5 The instrument contractor will provide an alignment drill template labeled with appropriate alignment, orientation, location reference information, and alignment cubes if necessary.

3.2.1.5 Alignment

3.2.1.5-1 The instrument contractor will measure the alignment between the sensor line-of-sight and the instrument alignment reference frame and deliver the results to the spacecraft contractor.

3.2.1.5-2 The spacecraft contractor is responsible for the alignment knowledge of the input axes of the spacecraft IRU with respect to the IRU reference frame.

3.2.1.5-3 The spacecraft contractor will document all alignment measurements in an alignment report.

3.2.1.5-4 The spacecraft and instrument contractors will negotiate and document in the ICD any relevant alignment requirements not specified in this document (GIRD).

3.2.1.5.1 Nadir and Body-Mounted Instrument Alignment

3.2.1.5.1.1 References

GIRD 129 3.2.1.5.1.1-1 The instrument **shall** include a permanent alignment reference on the instrument sensor unit composed of a minimum 2.54 cm alignment cube and a mounting surface datum. The instrument alignment cube defines the instrument alignment reference frame.

GIRD 131 3.2.1.5.1.1-2 The spacecraft inertial reference unit (IRU) **shall** include an alignment cube mounted on the IRU. This alignment cube defines the IRU reference frame. The IRU reference frame is the navigation reference frame of the spacecraft and is nominally parallel to the BRF.

GIRD132 3.2.1.5.1.1-3 The spacecraft IRU and instrument alignment cube pairs **shall** be viewable from two orthogonal directions.

3.2.1.5.1.1-4 The instrument contractor will document the location of all instrument optical alignment cubes in the IDD.

3.2.1.5.1.1-5 The instrument mounting frame is an orthogonal reference frame defined by the locations of the spacecraft side of the instrument mounting points. A rigorous definition of this frame will be documented in the ICD. The instrument mounting frame is nominally parallel to the BRF.

3.2.1.5.1.2 Responsibilities

3.2.1.5.1.2.-1 The spacecraft contractor will align the instrument alignment reference frame to the spacecraft IRU reference frame.

3.2.1.5.1.2-2 The spacecraft contractor will measure the alignment between the instrument alignment reference frame and the spacecraft IRU reference frame.

3.2.1.5.1.3 Placement

GIRD140 3.2.1.5.1.3.-1 The placement of the instrument alignment reference frame with respect to the spacecraft IRU reference frame **shall** be to within 0.25 degrees per axis (TBR), including variation over all launch and on-orbit environments

3.2.1.5.1.4 Initial Alignment Knowledge

GIRD142 3.2.1.5.1.4-1 The prelaunch alignment knowledge of the instrument alignment reference frame with respect to the spacecraft IRU input axes **shall** be 50 (TBR) microradians or better per axis.

3.2.1.5.1.5 On-Orbit Alignment Knowledge

GIRD1088 3.2.1.5.1.5-1 The on-orbit alignment knowledge of the instrument mounting frame with respect to the spacecraft IRU input axes **shall** be 50 (TBR) microradians or better, per axis. This requirement includes launch shift, on-orbit calibration uncertainty, on-orbit environments, and spacecraft structural and thermal stability.

GIRD1089 3.2.1.5.1.5-2 Contractor-specified operations for on-orbit calibration **shall** be consistent with the GOES-R operational concept, particularly as related to operational outages, as documented in **TBS**.

3.2.1.5.1.6 Alignment Rate of Change

GIRD144 3.2.1.5.1.6-1 The rate of change of the alignment of the instrument mounting frame with respect to the spacecraft IRU input axes **shall** not exceed 100 (TBR) microradians per hour per axis. This requirement includes on-orbit environments and spacecraft structural and thermal stability.

3.2.1.5.2 Solar Imaging Suite (SIS) Alignment

3.2.1.5.2.1 References

GIRD 1093 3.2.1.5.2.1-1 The SIS **shall** include a permanent alignment reference on the SIS unit composed of a minimum 2.54 cm alignment cube and a mounting surface datum. The SIS alignment cube defines the SIS alignment reference frame.

GIRD1094 3.2.1.5.2.1-2 The spacecraft Sun-Pointing Platform (SPP) **shall** include an alignment cube mounted on the SPP. This alignment cube defines the SPP reference frame. The SPP Coordinate Frame (SCF) is right-handed and is nominally parallel to this alignment cube. The X-axis of SCF nominally points to the center of the Sun. The elevation degree of freedom for the SCF to point to the Sun is provided by articulating the SPP about the Z-axis of the SCF. The Y-axis of the SCF completes the right-handed triad.

GIRD1095 3.2.1.5.2.1-3 The SPP and SIS alignment cube pairs **shall** be viewable from two orthogonal directions during the integration of the SIS Mounting Panel with the Sun-Pointing Platform.

3.2.1.5.2.1-4 The SIS contractor will document the locations of all instrument optical alignment cubes in the IDD.

3.2.1.5.2.1-5 The SIS reference coordinate system is defined as follows: The SIS X-axis is the boresight and is normal to the SIS YZ-plane. The SIS YZ-plane nominally contains the detector focal plane and the SIS Z-axis is nominally parallel to the SPP articulation axis.

3.2.1.5.2.2 Responsibilities

3.2.1.5.2.2-1 The spacecraft contractor will align the SIS Mounting Panel alignment reference frame to the spacecraft Sun-Pointing Platform reference frame.

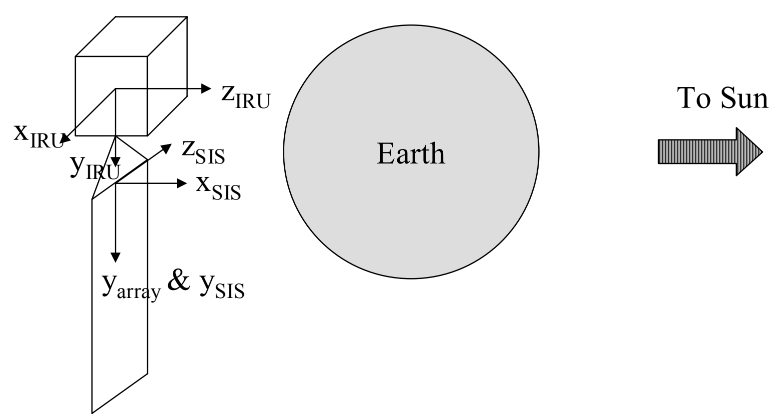
3.2.1.5.2.2-2 The spacecraft contractor will conduct analyses required to allocate the flow-down budget for the alignment between the SIS Mounting Panel and the SPP.

3.2.1.5.2.2-3 The spacecraft contractor will measure the alignment between the SIS alignment reference frame and the spacecraft SPP reference frame.

3.2.1.5.2.2-4 The spacecraft contractor is responsible for the alignment knowledge of the SIS with respect to the IRU reference frame.

3.2.1.5.2.3 Placement

GIRD1104 3.2.1.5.2.3-1 The configuration of the spacecraft and SIS at the spacecraft local midnight at equinox (See Figure Below) is defined when the SIS YZ plane is parallel with the IRU XY-plane, the placement of both the SIS Y- and Z-axes **shall** be within 0.3^{o} of the IRU Y- and X-axes, respectively, including variation over all launch and on-orbit environments.



Spacecraft & SIS Configuration at local midnight at equinox

3.2.1.5.2.4 Initial Alignment Knowledge

GIRD1106 3.2.1.5.2.4-1 The prelaunch alignment knowledge of the Sun-Pointing Platform alignment reference frame with respect to the spacecraft IRU input axes **shall** be TBD microradians or better, per axis.

		3.2.1.5.2.5 Alignment Rate of Change
GIRD 1108	3.2.1.5.2.5-1	The rate of change of the alignment of the Sun-Pointing Platform alignment reference frame with respect to the spacecraft IRU input axes **shall** not exceed TBD microradians per hour per axis. This requirement includes on-orbit environments and spacecraft structural and thermal stability.
		3.2.1.6 Access
GIRD146	3.2.1.6-1	The position of the instrument units on the spacecraft **shall** leave adequate clearance between the instrument and surrounding structures to provide access to instrument mounting hardware, access to instrument connectors, and space for instrument interfacing harness service loops.
	3.2.1.6-2	Instrument access requirements will be documented in the ICD.
GIRD148	3.2.1.6-3	All instrument units to be installed, removed or replaced at the satellite level **shall** be accessible without disassembly of the unit.
		3.2.1.7 Attitude and Disturbances for Nadir and Body-Mounted Instruments
	3.2.1.7-1	The requirements in this section apply to nadir-pointing instruments while the instrument is on orbit and operating and also to body-mounted space environment instruments.
		3.2.1.7.1 Spacecraft Attitude and Disturbances
GIRD1109	3.2.1.7.1-1	The interface attitude error and disturbance limits include government-held reserve and all spacecraft errors, including orbit and attitude knowledge, attitude command error, and attitude control error with all instruments operating in normal operational mode.
		3.2.1.7.1.1 Attitude Error
GIRD153	3.2.1.7.1.1-1	The attitude error of the instrument mounting frame relative to the desired ORF-referenced attitude **shall** not exceed ± 360 **(TBR)** microradians, 3-sigma, per axis. Attitude error is defined as the difference between the desired attitude and the actual, or true, attitude of the instrument mounting frame.
GIRD1067	3.2.1.7.1.1-2	The instrument mounting frame attitude **shall** be stable to within 500 microradians, peak-to-peak, 3-sigma, per axis, over any 60-second period of time.
		3.2.1.7.1.2 Attitude Error Rate
GIRD155	3.2.1.7.1.2-1	The instrument mounting frame attitude error rate relative to the desired ORF-referenced attitude **shall** not exceed ± 100 microradians per second, 3-sigma, per axis, when the rate is filtered by a fourth order Butterworth low pass filter with a -3dB frequency of 15 Hz.
		3.2.1.7.1.3 Spacecraft Translation Acceleration Limits
GIRD157	3.2.1.7.1.3-1	The translational accelerations at the spacecraft side of each instrument

sensor unit mount **shall** not exceed the limits specified in the Translational Acceleration Limits for Spacecraft to Instrument Table below. The limits apply to each orthogonal axis after the acceleration is bandpass-filtered using at least a fourth-order band-pass Butterworth filter with -3dB frequencies of f_1 and f_2. (Note that the filter has fourth-order rolloff on both sides of the response.) The accelerations can be present at any combination of the instrument sensor unit mounts and along any combination of the three orthogonal axes at each mount.

Translational Acceleration Limits for Spacecraft to Instrument Table

f_1 (Hz)	f_2 (Hz)	Peak Limit (mg)	f_1 (Hz)	f_2 (Hz)	Peak Limit (mg)	f_1 (Hz)	f_2 (Hz)	Peak Limit (mg)
0.0	512.0	15.0	26.9	30.2	0.4	114.0	128.0	1.4
0.9	10.1	1.5	28.5	32.0	0.4	120.8	135.6	1.4
6.3	32.0	1.0	30.2	33.9	1.4	128.0	143.7	1.4
20.2	101.6	3.0	32.0	35.9	1.4	135.6	152.2	1.4
64.0	322.5	7.0	33.9	38.1	1.4	143.7	161.3	1.4
203.2	512.0	14.0	35.9	40.3	1.4	152.2	170.9	1.4
9.0	10.1	0.4	38.1	42.7	1.4	161.3	181.0	1.4
9.5	10.7	0.4	40.3	45.3	1.4	170.9	191.8	1.4
10.1	11.3	0.4	42.7	47.9	1.4	181.0	203.2	1.4
10.7	12.0	0.4	45.3	50.8	1.4	191.8	215.3	1.4
11.3	12.7	0.4	47.9	53.8	1.4	203.2	228.1	1.4
12.0	13.5	0.4	50.8	57.0	1.4	215.3	241.6	1.4
12.7	14.3	0.4	53.8	60.4	1.4	228.1	256.0	1.4
13.5	15.1	0.4	57.0	64.0	1.4	241.6	271.2	1.4
14.3	16.0	0.4	60.4	67.8	1.4	256.0	287.4	1.4
15.1	17.0	0.4	64.0	71.8	1.4	271.2	304.4	1.4
16.0	18.0	0.4	67.8	76.1	1.4	287.4	322.5	1.4
17.0	19.0	0.4	71.8	80.6	1.4	304.4	341.7	1.4
18.0	20.2	0.4	76.1	85.4	1.4	322.5	362.0	1.4
19.0	21.4	0.4	80.6	90.5	1.4	341.7	383.6	1.4
20.2	22.6	0.4	85.4	95.9	1.4	362.0	406.4	1.4
21.4	24.0	0.4	90.5	101.6	1.4	383.6	430.5	1.4
22.6	25.4	0.4	95.9	107.6	1.4	406.4	456.1	1.4
24.0	26.9	0.4	101.6	114.0	1.4	430.5	483.3	1.4
25.4	28.5	0.4	107.6	120.8	1.4	456.1	512.0	1.4

GIRD1110 3.2.1.7.1.3-2 The translational accelerations at the spacecraft side of each instrument sensor unit mount **shall** produce an absolute peak acceleration Shock Response Spectra (SRS) less than the limits set in the On Orbit Operational SRS Acceleration Limits Table below. The limits apply to each orthogonal axis for SRS natural frequencies greater than or equal to f1 and less than f2 when using a quality factor, Q, of 50. The SRS is computed after the acceleration is high pass filtered with a fourth order Butterworth filter with a -3dB cut off at 1.0 Hz.

On Orbit Operational SRS Acceleration Limits Table

f_1 (Hz)	f_2 (Hz)	SRS Limit (mg)
10	30	10.0
30	90	30.0
90	300	45.0

3.2.1.7.2 Instrument-to-Spacecraft Disturbances

3.2.1.7.2.1 Instrument Disturbance Torque Limits

GIRD160 3.2.1.7.2.1-1 At any time during the operational mode of the spacecraft, the sum of the magnitude of the instrument sensor unit's uncompensated torques and the magnitude of its uncompensated linear forces multiplied by a lever arm of 2 meters **shall** not exceed 1.0 N-m.

3.2.1.7.2.2 Instrument Allowable Angular Momentum

GIRD162 3.2.1.7.2.2-1 The magnitude of the instrument unit's uncompensated angular momentum **shall** not exceed 1.0 N-m-sec.

3.2.1.7.2.2-2 The instrument contractor will document the angular momentum produced by the instrument in the IDD.

3.2.1.7.2.3 Instrument Disturbances Allocation

GIRD165 3.2.1.7.2.3-1 The instrument **shall** not exceed disturbances defined in the UIID given a spacecraft characterized by Laplace domain transfer functions $H_{\theta T}(s)$, $sH_{\theta T}(s)$ and $as^2H_{\theta T}(s)$ with the parameters in the tables named Parameters for Roll Torques and Rotations about the X Axis, Parameters for Pitch Torques and Rotations about the Y Axis, and Parameters for Yaw Torques and Rotations about the Z Axis.

Filtering the instrument sensor unit torque time history in Newton-meter units with $H_{\theta T}(s)$ estimates the spacecraft pointing error displacement in radian units. Filtering with $sH_{\theta T}(s)$ estimates the spacecraft pointing error rate in radians per second units. Filtering with $as^2H_{\theta T}(s)$ estimates the spacecraft linear acceleration at a mount in meters per second per second units. When filtering roll axis torques with $H_{\theta T}(s)$, $sH_{\theta T}(s)$ and $as^2H_{\theta T}(s)$, use table Parameters for Roll Torques and Rotations about the X Axis. When filtering pitch, use table Parameters for Pitch Torques and Rotations about the Y Axis. When filtering yaw, use table Parameters for Yaw

Torques and Rotations about the Z Axis. Transfer function $H_{\theta T}(s)$ is plotted in Figure Torque to Spacecraft Pointing Error Transfer Functions for roll, pitch and yaw.

Torque to Angular Displacement Transfer Function

$$\frac{\theta(s)}{T(s)} = H_{\theta T}(s)$$

Torque to Angular Rate Transfer Function

$$\frac{\dot{\theta}(s)}{T(s)} = sH_{\theta T}(s)$$

Torque to Translational Acceleration Transfer Function

$$\frac{\ddot{x}(s)}{T(s)} = as^2 H_{\theta T}(s)$$

where

$$H_{\theta T}(s) = \sum_{i=1}^{n} \frac{1/J_i}{s^2 + 2\zeta_i \omega_i s + \omega_i^2}$$ and $$\omega_i = 2\pi f_i$$.

Parameters for Roll Torques and Rotations about the X Axis

a (m)	*n*	*i*	f_i (Hz)	ζ_i (%)	J_i (kg-m^2)
1.5	12	1	0.01	30.0	4721
		2	0.40	2.0	10733
		3	1.34	0.1	59081
		4	1.92	0.1	34514
		5	13.24	0.1	972
		6	16.54	0.1	732
		7	23.56	0.1	3468
		8	30.55	0.1	5017
		9	30.91	0.1	2975
		10	31.00	0.1	1313
		11	31.17	0.1	1204
		12	39.36	0.1	25821

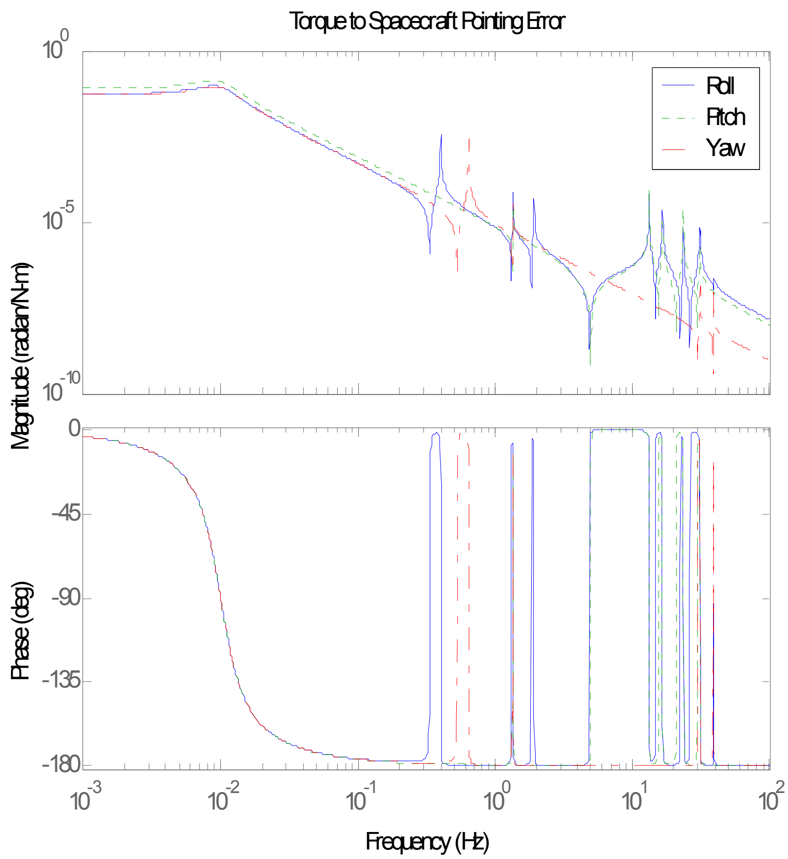
Parameters for Pitch Torques and Rotations about the Y Axis

a (m)	*n*	*i*	f_i (Hz)	ζ_i (%)	J_i (kg-m^2)
1.5	9	1	0.01	30.0	3203
		2	1.35	0.1	89061
		3	13.24	0.1	820
		4	16.54	0.1	1620
		5	23.56	0.1	985
		6	30.55	0.1	55722
		7	30.91	0.1	8377
		8	31.00	0.1	3897
		9	31.17	0.1	6104

Parameters for Yaw Torques and Rotations about the Z Axis

a (m)	*n*	*i*	f_i (Hz)	ζ_i (%)	J_i (kg-m^2)
1.5	5	1	0.01	30.0	4873
		2	0.64	2.0	10001
		3	1.35	0.1	76471
		4	31.00	0.1	45578
		5	39.36	0.1	73013

Torque to Spacecraft Pointing Error Transfer Functions



3.2.1.8 Attitude Errors and Disturbances for SIS

GIRD1112 3.2.1.8-1 The requirements in this section apply to SIS, located on the Sun-Pointing Platform (SPP) while all the instruments and mechanisms on-board the spacecraft in-orbit are operating. The Sun-Pointing Platform interface Sun-pointing error and disturbance limits include government-held reserve and all spacecraft errors, including orbit and attitude knowledge, attitude command error, and attitude control error with all instruments operating in normal operational mode.

3.2.1.8-2 The North-South and East-West directions correspond to the elevation and azimuth directions, respectively, of the center of the Sun when viewed from the Sun-Pointing Platform.

3.2.1.8.1 Spacecraft-to-Instrument Disturbances

3.2.1.8.1.1 Sun-Pointing Platform Attitude Error and Stability

GIRD1116	3.2.1.8.1.1-1	Using the Sun-pointing error data provided by the SIS, the spacecraft **shall** point the SIS to the Sun to within ± 2.3 arcminutes (3-sigma, per axis) of the Sun center.
GIRD1138	3.2.1.8.1.1-2	If the Sun-pointing error data from the SIS is not available, the spacecraft **shall** point the line-of-sight to the Sun in the SIS Mounting Panel Coordinate Frame to within ± 1.5 arc-minutes **(TBR)**, 3-sigma, per axis, of the Sun center.
GIRD1117	3.2.1.8.1.1-3	The Sun-pointing attitude error of the Sun-Pointing Platform **shall** be stable to within 18 arc-seconds **(TBR)**, 3-sigma, per axis, peak-to-peak, over the 20-second SIS exposure period of time, for each of the North-South and East-West axes, excluding the blackbody calibration durations of the nadir-pointing instruments.
GIRD1118	3.2.1.8.1.1-4	In addition, the Sun-pointing in the North-South or East-West direction **shall** be stable to within 100 arc-seconds (**TBR**), 3 sigma, per axis, peak-to-peak, over 60-seconds, with no exclusions.

3.2.1.8.1.2 Sun-Pointing Attitude Error Rate

GIRD1120	3.2.1.8.1.2-1	The Sun-Pointing Platform attitude error rate **shall** not exceed +/-100 microradians per second, 3-sigma, per axis, when the rate is filtered by a fourth-order Butterworth low pass filter with a -3dB frequency of 15 Hz.

3.2.1.8.1.3 Sun-pointing Attitude Knowledge

GIRD1122	3.2.1.8.1.3-1	The spacecraft-provided knowledge of the Sun-pointing error of the Sun-Pointing Platform **shall** not exceed 10 arc-seconds (TBR).

3.2.1.8.1.4 East-West and North-South Bias-pointing

GIRD1124	3.2.1.8.1.4-1	The spacecraft **shall** provide a ground-commandable bias-pointing capability for the SPP in each of the East-West and North-South directions.
GIRD1125	3.2.1.8.1.4-2	The bias range **shall** be at least ± 40 arc-minutes about the Sun line, in one arc-minute or smaller increments.
GIRD1126	3.2.1.8.1.4-3	The East-West and North-South bias pointing accuracy requirements **shall** be the same for the non-bias pointing in Section titled Sun-Pointing Platform Attitude Error and Stability.

3.2.1.8.2 Instrument-to-Spacecraft Disturbances

3.2.1.8.2.1 Instrument Disturbance Torque Limits

GIRD1129	3.2.1.8.2.1-1	At any time during the operational mode of the spacecraft, the sum of the magnitude of the instrument sensor unit's uncompensated torques and the magnitude of its uncompensated linear forces multiplied by a lever arm of 2 meters **shall** not exceed 0.2 (TBR) N-m.
GIRD1130	3.2.1.8.2.1-2	The instrument's uncompensated torque vs. time characteristic **shall** be shaped so as to minimize the excitation of the flexible modes of vibration of

the spacecraft.

3.2.1.8.2.2 Instrument Allowable Angular Momentum

GIRD1132 3.2.1.8.2.2-1 The magnitude of the instrument unit's uncompensated angular momentum **shall** not exceed 0.1 (TBR) N-m-sec.

3.2.1.8.2.2-2 The instrument contractor will document the angular momentum produced by the instrument in the IDD.

3.2.1.9 Flight and Non-Flight Equipment

3.2.1.9-1 The instrument contractor will provide information on all items to be installed or removed prior to flight for identification in the IDD.

3.2.1.9-2 The instrument contractor will tag all non-flight items to be removed prior to flight with a red tag stating, "**Remove Before Flight**".

3.2.1.9-3 The instrument contractor will tag all flight items to be installed prior to flight with a green tag stating, "**Install Before Flight**".

3.2.2 Thermal

3.2.2.1 Thermal Control Concept

3.2.2.1-1 The instrument units installed on the spacecraft bus fall under one of the following categories:

a) Thermally-independent units are conductively and radiatively decoupled from the spacecraft and reject their heat directly to space.
b) Thermally-coupled units dissipate their heat to the spacecraft.
c) Solar Pointing instruments are special thermally isolated case, where the SIS mounting plate is isolated from the spacecraft solar array yoke and tilt motor and actuator.
In general:

- Instrument <u>electronic units</u> are thermally-coupled.
- Instrument <u>sensor units</u> are thermally-independent.

The instrument contractor will document the thermal control concept in the IDD.

GIRD844 3.2.2.1-2 The spacecraft **shall** maintain the instrument units mounting surface temperature within instrument Mission Allowable Temperatures (MAT) during instrument operation.

GIRD845 3.2.2.1-3 The spacecraft **shall** maintain the instrument units mounting surface temperature within non-operational limits when the instrument is non-operating.

3.2.2.1.1 Independent Thermal Control Design

3.2.2.1.1-1 The instrument contractor is responsible for independent thermal unit thermal design.

GIRD1141 3.2.2.1.1-2 Thermally-independent instrument units **shall** restrict heater power consumption within overall power limitations.

3.2.2.1.2 Coupled Thermal Control Design

3.2.2.1.2-1 The instrument contractor is responsible for thermally coupled unit internal thermal design. For coupled units, the instrument contractor will provide unit internal design information including internal dissipation, couplings, and interface heat flow so the spacecraft contractor can appropriately interface with the unit.

3.2.2.2 Heat Transfer

3.2.2.2-1 The net heat transfer (conducted and radiated) is the total amount of heat transferred between the instrument units and the spacecraft.

3.2.2.2.1 Independent Unit - Heat Transfer

3.2.2.2.1-1 The net heat transfer between the independent unit and spacecraft includes radiation between adjacent instrument and spacecraft surfaces, conduction via the mechanical interface and conduction via the instrument harness.

3.2.2.2.2 Independent Unit - Net Heat Transfer

GIRD185 3.2.2.2.2-1 For Independent Units, the net heat transfer averaged over the instrument independent unit interface plane area **shall** be less than 15.5 watts/m^2.

3.2.2.2.3 Coupled Unit Heat Transfer

GIRD187 3.2.2.2.3-1 The spacecraft **shall** provide a heat rejection path for thermally coupled units.

Units with less than 5 watts dissipation may rely on radiative rather than conductive heat rejection subject to agreement of the instrument and spacecraft contractors.

Where conduction is the principal heat transfer mechanism, the interface temperature is the spacecraft side of the mechanical interface.

For radiatively-coupled units (accommodated within the spacecraft) the interface temperature is the average local environment surrounding unit external surfaces.

3.2.2.2.4 Coupled Unit - Net Heat Transfer

GIRD189 3.2.2.2.4-1 The net heat transfer collectively from the instrument's coupled units to the spacecraft **shall** not exceed the values dictated by the UIID.

3.2.2.2.5 Coupled Unit - Heat Transfer Flux Density

GIRD191 3.2.2.2.5-1 For conductively-coupled units, peak local heat transfer fluxes conducted to the spacecraft in excess of 0.25 watts per square centimeter **shall** be

		coordinated with the spacecraft contractor and subject to NASA concurrence.
	3.2.2.2.5-2	Where this watt density is exceeded, the spacecraft contractor will provide a detailed description of the heat transport features and SINDA model of the spacecraft side interface.

3.2.2.3 Interface Temperatures

GIRD201	3.2.2.3-1	For planning and preliminary design purposes, the interface temperature (spacecraft side) for Earth-viewing instruments **shall** be: a) 0°C to 40°C during operation b) -30°C to 50°C during non-operation
GIRD202	3.2.2.3-2	If a temperature-controlled nadir platform is employed, the spacecraft **shall** maintain the temperature of the nadir platform between 25°C ±1°C (TBR) during operations.

3.2.2.4 Temperature Monitoring

3.2.2.4.1 Mechanical Interface Temperature Monitoring

	3.2.2.4.1-1	The instrument contractor will select a unit attachment point and identify it on the IDD.
GIRD206	3.2.2.4.1-2	The spacecraft **shall** have a temperature sensor adjacent to this attachment point (on the spacecraft side) to serve as the interface temperature sensor.

3.2.2.4.2 Instrument Critical Temperatures

GIRD208	3.2.2.4.2-1	The spacecraft **shall** convey instrument critical temperatures via the spacecraft telemetry stream.
	3.2.2.4.2-2	The type(s) of temperature sensor and excitation will be collectively selected by the instrument contractor and spacecraft contractor and is subject to NASA concurrence.
	3.2.2.4.2-3	The instrument contractor will procure and install the critical temperature sensors.
	3.2.2.4.2-4	The instrument contractor will furnish temperature calibration coefficients for the critical temperature sensors and document them in the IDD.

3.2.2.4.3 Instrument Non-Critical Temperatures

GIRD213	3.2.2.4.3-1	The instrument **shall** report instrument non-critical temperatures in telemetry.

3.2.2.5 Heater Power and Heater Control

GIRD217	3.2.2.5-1	The two categories of instrument heaters are: Operational heaters controlled by the instrument Non-operational (survival) heaters powered by the spacecraft When the instrument is OFF, the instrument survival heaters **shall** consume

no more than 35% of nominal operational power (of the independent units) averaged over every 72 minute period.

3.2.2.6 Thermal Interfaces

3.2.2.6.1 Mounting Details

GIRD221 3.2.2.6.1-1 The spacecraft contractor will document in the ICD properties of any thermally conductive or isolating mateirals used at the interface of the instrument unit.

3.2.2.6.2 Contact Area

GIRD224 3.2.2.6.2-1 Unit mounting contact area on the instrument and spacecraft **shall** be unpainted.

3.2.2.6.3 Interstitial Materials

GIRD226 3.2.2.6.3-1 The spacecraft contractor will integrate the instrument units onto the spacecraft including application of any interstitial materials as conductive enhancements. Selection and application of any interface materials require the concurrence of the instrument contractor and spacecraft contractor.

3.2.2.7 Multi-layer Insulation

GIRD1080 3.2.2.7-1 Multi-layer insulation (MLI) **shall** have provisions for electrical grounding to prevent ESD

GIRD1081 3.2.2.7-2 MLI vents **shall** be located and oriented consistent with observatory contamination requirements.

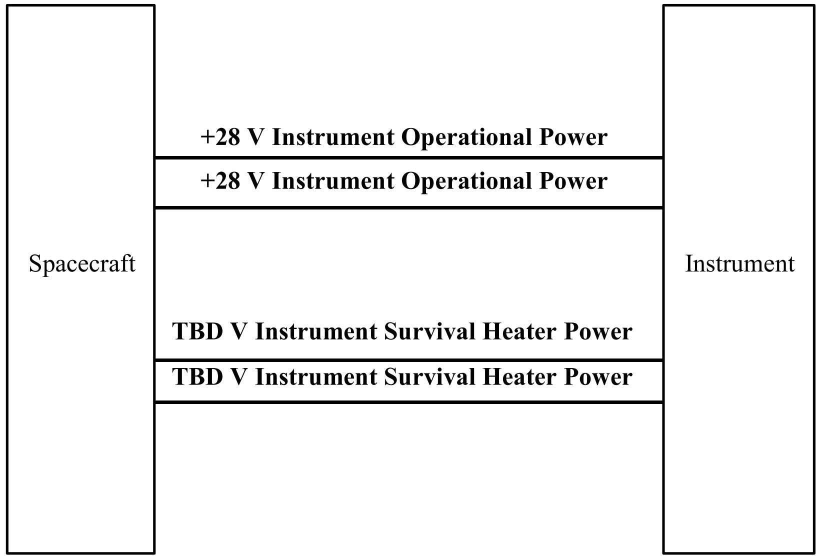
3.2.3 Instrument Electrical Power

GIRD230 3.2.3-1 The spacecraft **shall** supply an instrument operational power bus, and an instrument survival heater power bus to the instrument as specified in the Instrument Electrical Power Figure.

The instrument operational power bus is a filtered +28 V power provided by the spacecraft to the instrument to operate the instrument.

The instrument survival heater power is TBD V power provided by the spacecraft to the instrument to power the instrument survival heaters.

Instrument Electrical Power Figure



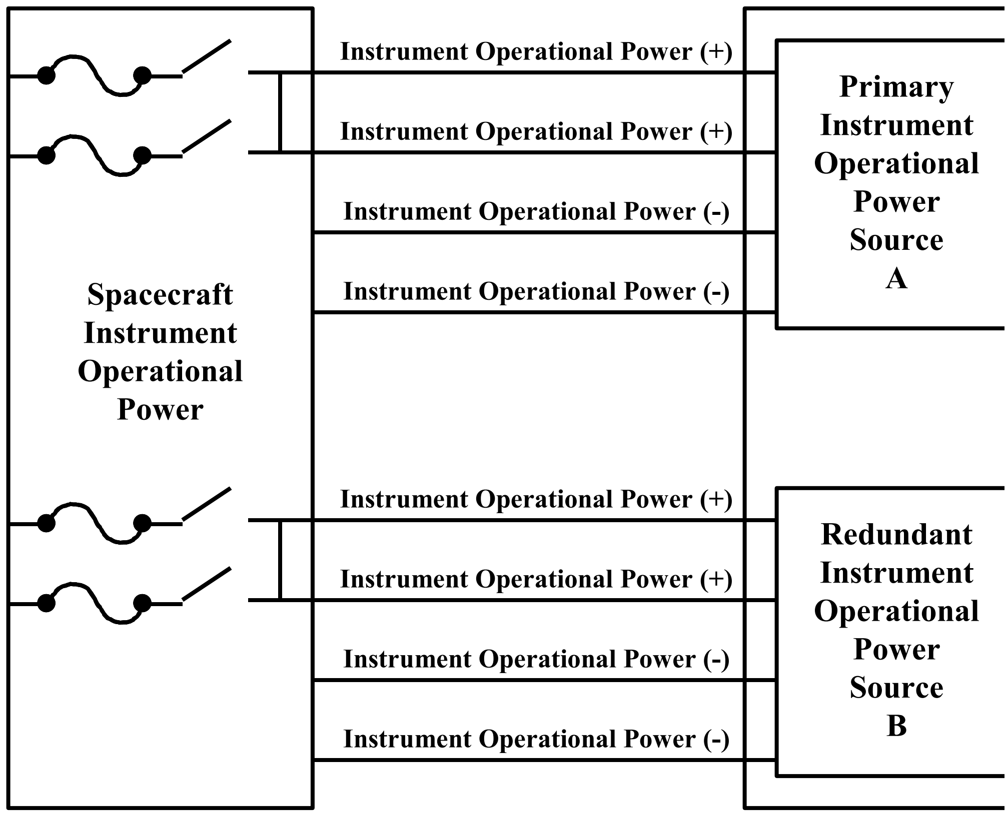
3.2.3.1 Instrument Operational Power

3.2.3.1.1 Instrument Operational Power Distribution

3.2.3.1.1.1 Instrument Operational Power Lines

GIRD233 3.2.3.1.1.1-1 The spacecraft **shall** supply instrument operational power distribution to the instrument operational power input connector for primary and redundant instrument operational power sources as specified in the Operational Power Lines Figure.

Operational Power Lines Figure



GIRD925 3.2.3.1.1.1-2 The spacecraft **shall** control the instrument operational power harness voltage drop to less than .50 V roundtrip.

GIRD926 3.2.3.1.1.1-3 The spacecraft **shall** sense and telemeter the instrument operational power current being supplied to the primary instrument operational power source(s).

GIRD936 3.2.3.1.1.1-4 The spacecraft **shall** sense and telemeter the instrument operational power current being supplied to the redundant instrument operational power source(s).

3.2.3.1.1.2 Instrument Operational Power On/Off Functionality

GIRD235 3.2.3.1.1.2-1 The spacecraft **shall** provide redundant commanding to switch instrument operational power on and off to the instrument operational power input connector.

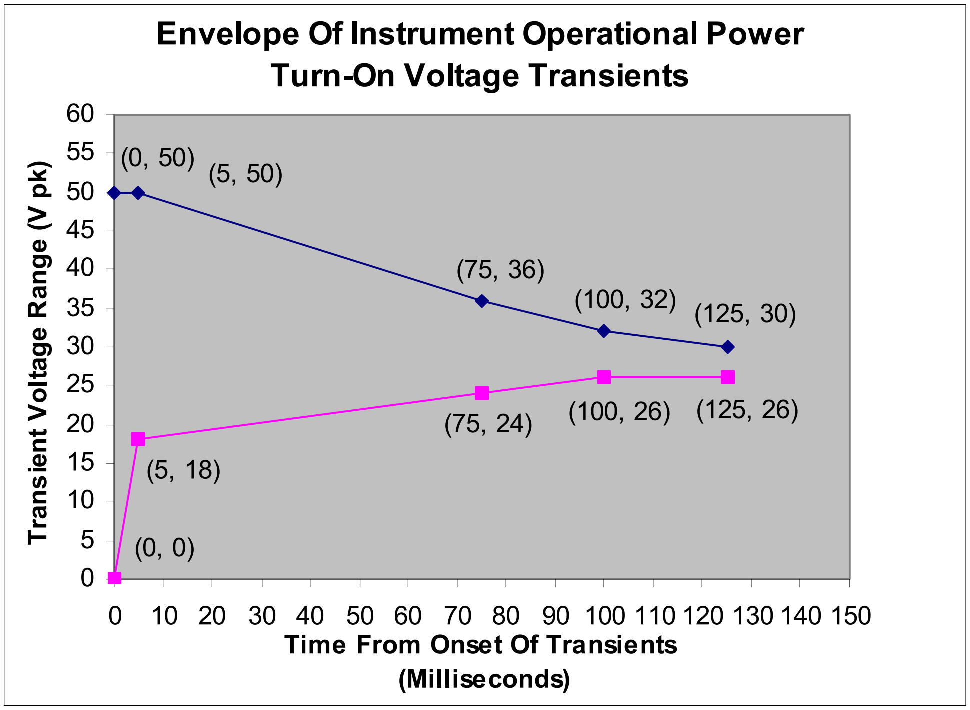
GIRD236 3.2.3.1.1.2-2 The spacecraft **shall** provide redundant instrument operational power on and off status telemetry.

GIRD237 3.2.3.1.1.2-3 The spacecraft **shall** supply redundant switching of instrument operational power to the instrument operational power input connector.

GIRD238 3.2.3.1.1.2-4 The instrument **shall** accept switched power at the instrument operational power input connector.

3.2.3.1.1.3 Instrument Operational Power Overcurrent Protection

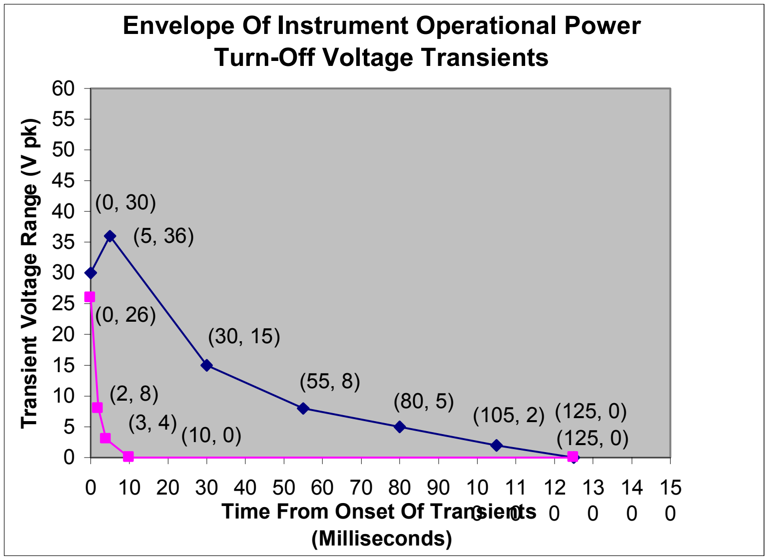
GIRD240	3.2.3.1.1.3-1	The spacecraft **shall** protect the instrument operational power harnessing to the instrument operational power input connector from instrument operational power short-to-ground faults.
		3.2.3.1.2 Instrument Operational Power DC Voltage
GIRD242	3.2.3.1.2-1	The spacecraft **shall** supply a steady-state dc voltage of 28 Vdc ± 2 Vdc at the instrument operational power input connector.
GIRD243	3.2.3.1.2-2	The instrument **shall** operate in accordance with the instrument performance specification with a steady-state dc voltage of 28 Vdc ± 2 Vdc applied at the instrument operational power input connector.
		3.2.3.1.3 Instrument Operational Power Voltage Transients
		3.2.3.1.3.1 Instrument Operational Power Turn-On Step Load Voltage Transient
GIRD246	3.2.3.1.3.1-1	The spacecraft **shall** control the instrument operational power turn-on step load voltage transient at the spacecraft's instrument operational power connector of the spacecraft's instrument operational power unit(s) to less than or equal to 2 V below the measured steady state dc voltage, and shall recover to its steady state value in less than 5 milliseconds.
GIRD247	3.2.3.1.3.1-2	The spacecraft **shall** control the instrument operational power turn-on step load voltage transient at the instrument operational power input connector to levels and durations within the voltage transient envelope defined in **GIRD249** for any predefined steady state load condition of the operational power unit.
GIRD249	3.2.3.1.3.1-3	The instrument **shall** meet the instrument performance specification after exposure to the instrument operational power turn-on voltage transients defined in the Envelope of Instrument Operational Power Turn-on Voltage Transients Figure.



3.2.3.1.3.2 Instrument Operational Power Turn-Off Step Load Voltage Transient

GIRD251 3.2.3.1.3.2-1 The spacecraft **shall** control the instrument operational power turn-off step load voltage transient at the spacecraft's instrument operational power connector of the spacecraft's instrument operational power unit(s) to less than or equal to 2 V above the measured steady state dc voltage and shall recover to its steady state value in less than 5 milliseconds.

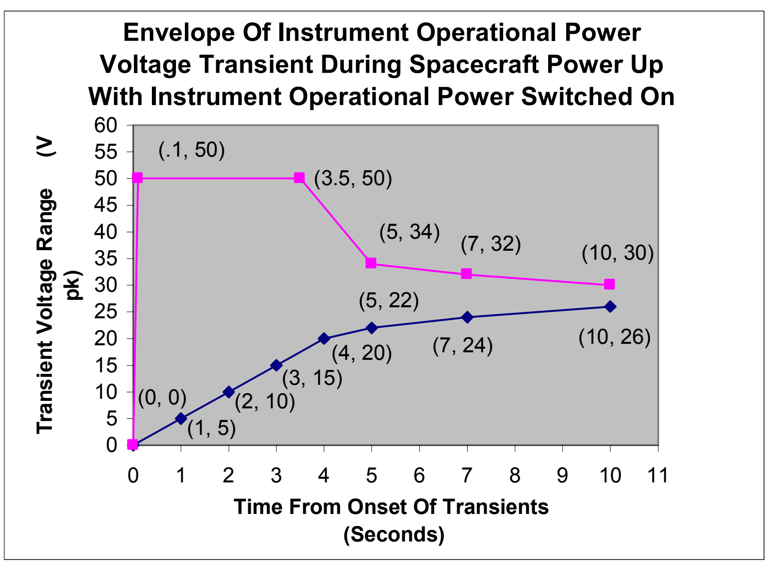
GIRD252 3.2.3.1.3.2-2 The spacecraft **shall** control the instrument operational power turn-off step load voltage transient at the instrument operational power input connector to levels and duration's within the voltage transient envelope defined in the Envelope of Instrument Operational Power Turn-off Voltage Transients Figure for any predefined steady state load condition of the operational power unit.



GIRD254 3.2.3.1.3.2-3 The instrument **shall** meet the instrument performance specification after exposure to the instrument operational power turn-off voltage transients defined in **GIRD252**.

3.2.3.1.3.3 Instrument Operational Power Start-up Transient

GIRD256 3.2.3.1.3.3-1 During a spacecraft power-up with the instrument operational power switched on, the spacecraft **shall** control the voltage transient at the instrument operational power input connector to levels and duration's within the voltage transient envelope defined in the Envelope of Instrument Operational Power Voltage Transient During Spacecraft Power-up with Instrument Operational Power Switched on Figure.

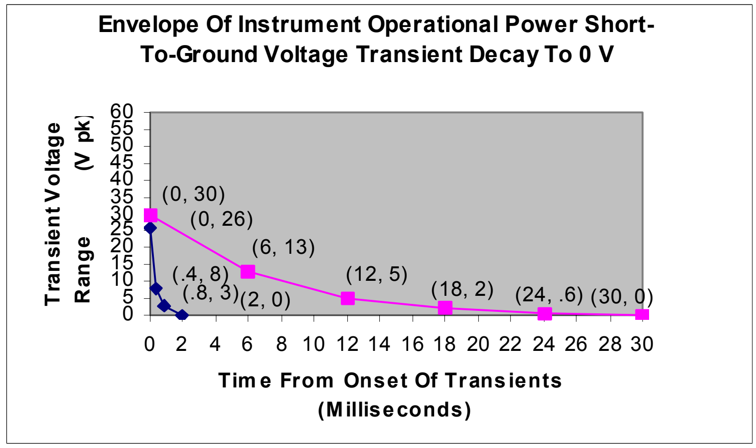


GIRD257 3.2.3.1.3.3-2 The instrument **shall** meet the instrument performance specification after exposure to the instrument operational power start-up voltage transients defined in GIRD256.

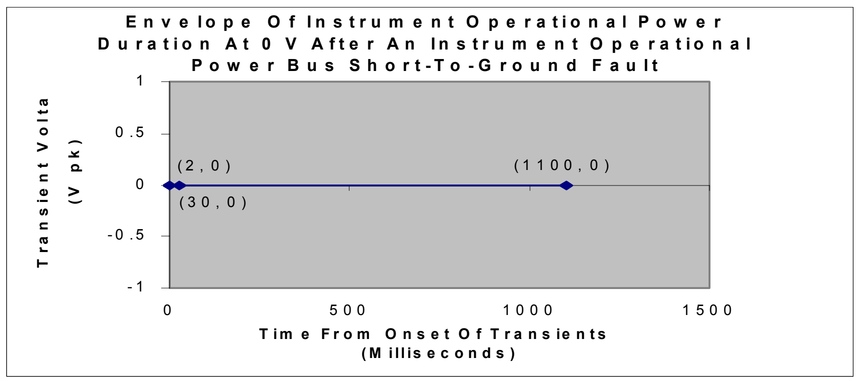
3.2.3.1.3.4 Instrument Operational Power Bus Short-to-Ground Voltage Transient

GIRD259	3.2.3.1.3.4-1	During an instrument operational power bus short-to-ground with the instrument operational power bus drawing its maximum steady-state on-orbit load, the spacecraft **shall** control the instrument operational power bus short to ground voltage transient to levels and duration's within the voltage transient envelopes defined in **GIRD260**.
GIRD260	3.2.3.1.3.4-2	The instrument **shall** meet the instrument performance specification after exposure to the instrument operational power bus short-to-ground voltage transients defined in the Short to Ground Transient Decay Figure, the Short to Ground Zero Duration Figure, and the Short to Ground Ramp-up Figure.

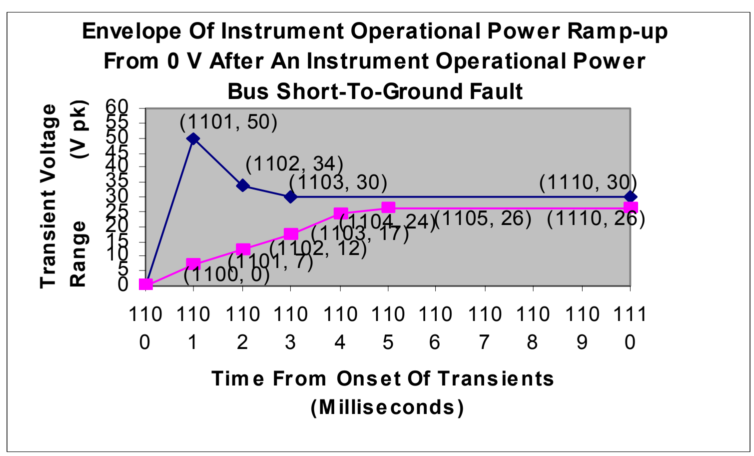
Short to Ground Transient Decay Figure



Short to Ground Zero Duration Figure



Short to Ground Ramp-up Figure

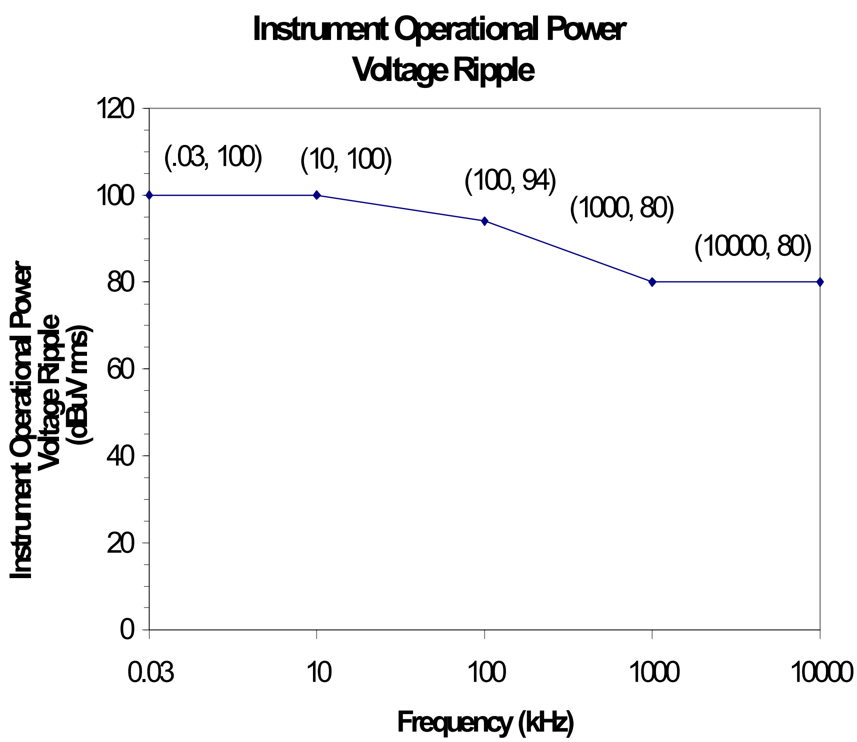


3.2.3.1.3.5 Instrument Operational Power Overvoltage Fault Transient

GIRD262	3.2.3.1.3.5-1	The spacecraft **shall** control an instrument operational power overvoltage fault transient at the instrument operational power input connector to a peak voltage of 40 V.
GIRD263	3.2.3.1.3.5-2	The spacecraft **shall** recover the instrument operational power to the steady-state instrument operational power dc voltage defined in **GIRD243** within 300 milliseconds of an instrument operational power overvoltage fault.
GIRD264	3.2.3.1.3.5-3	The instrument **shall** meet the instrument performance specification after exposure to the instrument operational overvoltage fault transient defined in **GIRD262**.

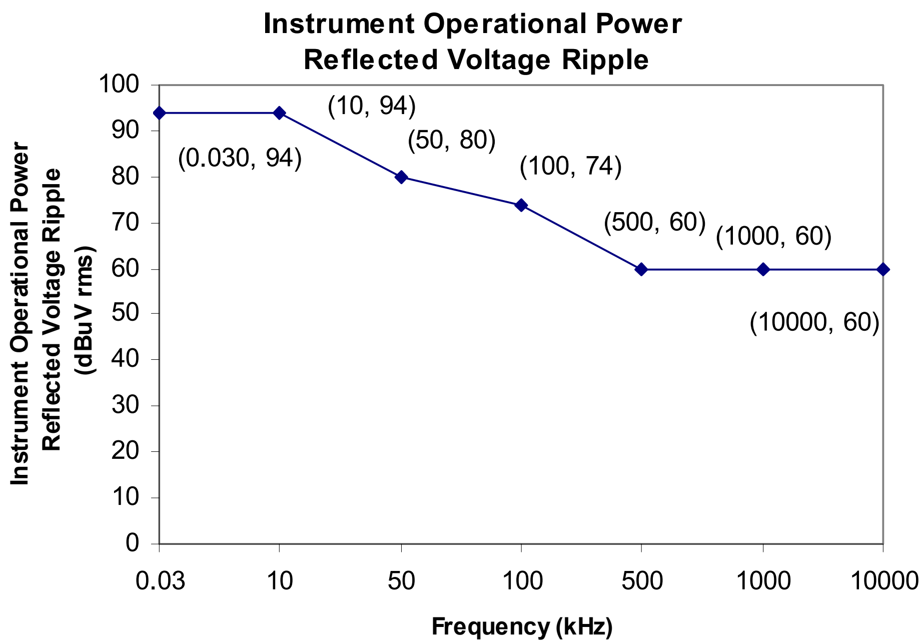
3.2.3.1.4 Instrument Operational Power Voltage Ripple

GIRD266	3.2.3.1.4-1	The spacecraft **shall** control the instrument operational power voltage ripple supplied at the instrument operational power input connector to levels that are at or within those levels specified in the Instrument Operational Power Voltage Ripple Figure for all operating modes with all spacecraft power system buses loaded at their maximum steady-state on-orbit load.



GIRD267	3.2.3.1.4-2	Test measurements **shall** be in accordance with MIL-STD-461E.
GIRD268	3.2.3.1.4-3	The instrument **shall** meet the instrument performance specification after exposure to the spacecraft-supplied instrument operational power voltage ripple at the instrument operational power input connector that is at or within the levels defined in **GIRD266**.
GIRD269	3.2.3.1.4-4	The instrument **shall** control its reflected ripple onto the instrument

operational power bus for all operating modes when it is drawing its maximum steady-state on-orbit power to levels that are at or within those levels defined in the Instrument Operational Power Reflected Voltage Ripple Figure.



GIRD270 3.2.3.1.4-5 Test measurements **shall** be in accordance with MIL-STD-461 E.

3.2.3.1.5 Instrument Operational Power Consumption

GIRD272 3.2.3.1.5-1 The spacecraft **shall** satisfy the instrument operational power requirements defined in the UIID.

GIRD273 3.2.3.1.5-2 The instrument **shall** draw no more than the instrument operational power consumption's defined in the UIID.

3.2.3.1.6 Instrument Operational Power Current Transients

3.2.3.1.6.1 Instrument Operational Power Turn-On Current Transient

GIRD278 3.2.3.1.6.1-1 The instrument **shall** limit its instrument operational power turn-on current transient(s) to no more than 6A peak with a ramp-up rate less than 2A/microsecond.

GIRD928 3.2.3.1.6.1-2 The instrument **shall** control the instrument operational power turn-on current transient(s) within 125% of the maximum steady-state current draw within 20 milliseconds.

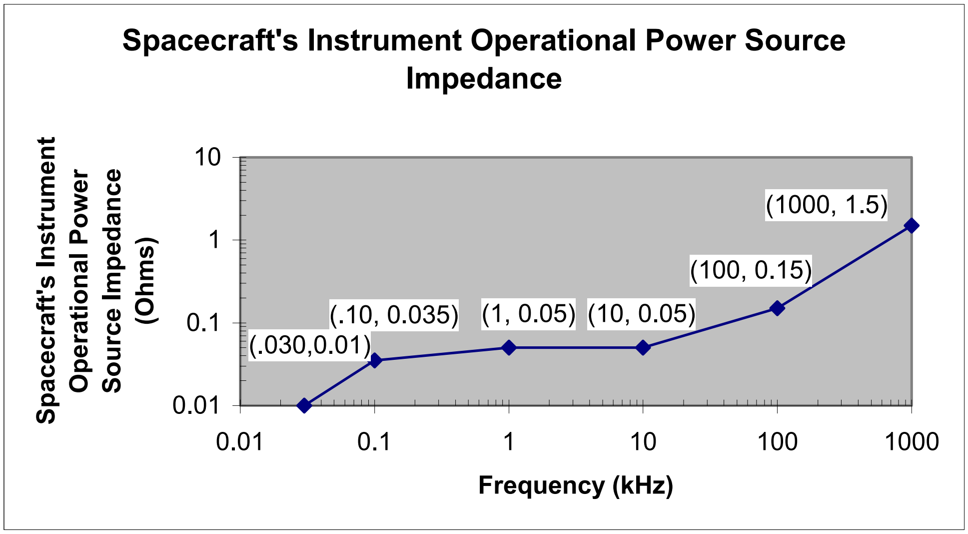
3.2.3.1.6.2 Instrument Operational Power Turn-Off Current Transient

GIRD280 3.2.3.1.6.2-1 The instrument **shall** limit its instrument operational power turn-off current transient(s) to no more than 6A peak.

3.2.3.1.7 Instrument Operational Power Impedance

3.2.3.1.7.1 Spacecraft's Instrument Operational Power Source Impedance

GIRD944 3.2.3.1.7.1-1 The spacecraft **shall** control its instrument operational power source impedance within those levels specified in the Spacecraft's Instrument Operational Power Source Impedance Figure.



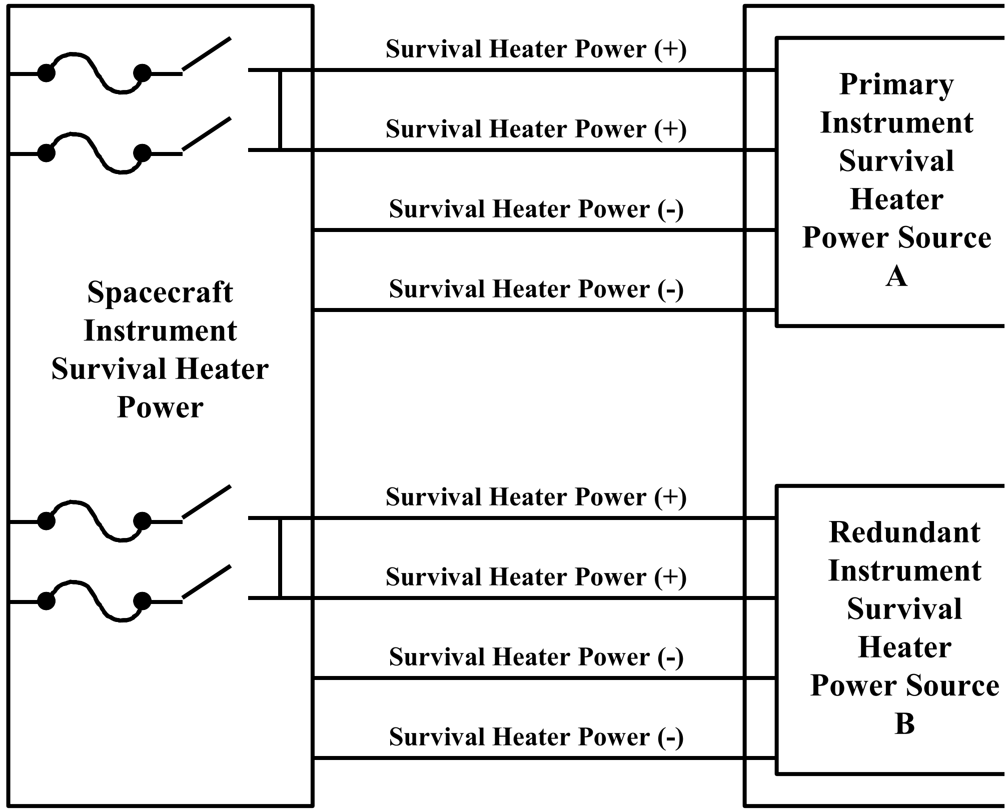
3.2.3.2 Instrument Survival Heater Power

3.2.3.2.1 Instrument Survival Heater Power Distribution

3.2.3.2.1.1 Instrument Survival Heater Power Lines

GIRD346 3.2.3.2.1.1-1 The spacecraft **shall** supply a single fault tolerant instrument survival heater power distribution to the instrument survival heater power input connector for primary and redundant instrument survival heater power sources as specified in the Survival Heater Power Lines Figure.

Survival Heater Power Lines Figure



GIRD347	3.2.3.2.1.1-2	The spacecraft **shall** control the instrument roundtrip survival heater power harness voltage drop to less than 2% of the instrument survival heater power nominal steady state dc voltage.

3.2.3.2.1.2 Instrument Survival Heater Power On/Off Functionality

GIRD349	3.2.3.2.1.2-1	The spacecraft **shall** provide redundant commanding to switch instrument survival heater power ON and OFF to the instrument survival heater power input connector.
GIRD350	3.2.3.2.1.2-2	The spacecraft **shall** provide redundant instrument survival heater power ON and OFF status telemetry.
GIRD351	3.2.3.2.1.2-3	The spacecraft **shall** supply redundant switching of instrument survival heater power to the instrument survival heater power input connector.
GIRD352	3.2.3.2.1.2-4	The instrument **shall** accept switched power at the instrument survival heater power input connector.

3.2.3.2.1.3 Instrument Survival Heater Power Overcurrent Protection

GIRD354	3.2.3.2.1.3-1	The spacecraft **shall** protect the instrument survival heater power harnessing to the instrument survival heater power input connector from instrument survival heater power short-to-ground faults.

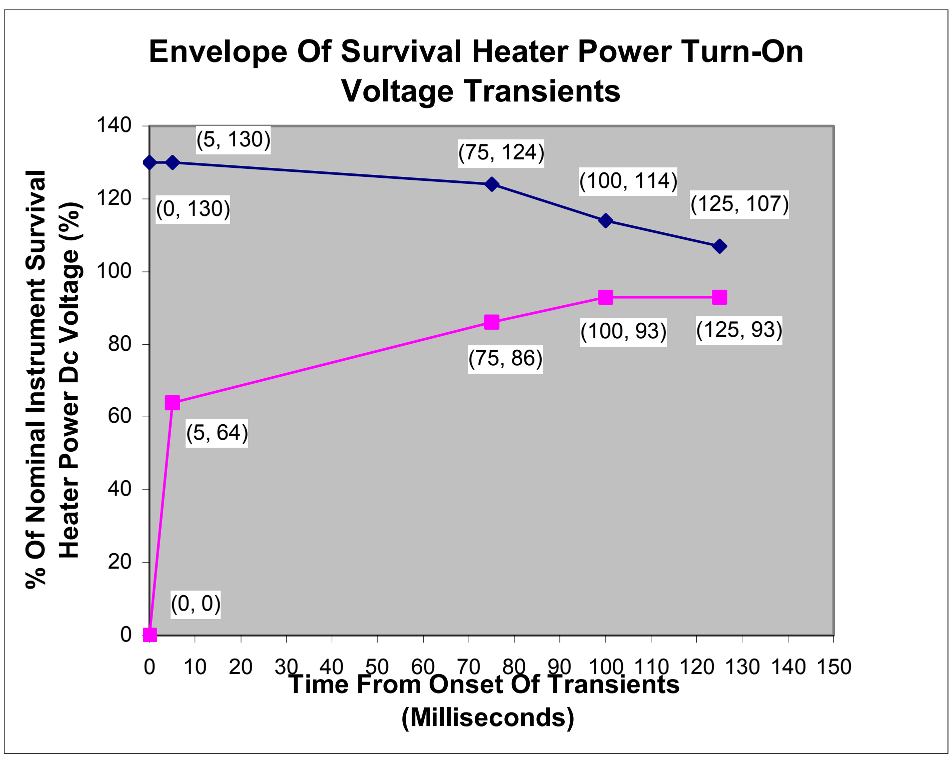
3.2.3.2.2 Instrument Survival Heater Power DC Voltage

GIRD356	3.2.3.2.2-1	The spacecraft **shall** supply a steady-state dc voltage of TBD Vdc at the instrument survival heater power input connector.
GIRD357	3.2.3.2.2-2	The instrument **shall** be in accordance with the instrument performance specification with a steady-state dc voltage of TBD Vdc applied at the instrument survival heater power input connector.

3.2.3.2.3 Instrument Survival Heater Power Voltage Transients

3.2.3.2.3.1 Instrument Survival Heater Power Turn-On Step Load Voltage

GIRD360	3.2.3.2.3.1-1	The spacecraft **shall** control the instrument survival heater power turn-on step load voltage transient at the spacecraft's instrument survival heater power connector of the spacecraft's instrument survival heater power unit(s) to less than or equal to 2 V below the measured steady state dc voltage.
GIRD361	3.2.3.2.3.1-2	When the spacecraft instrument survival heater power bus is drawing its maximum steady state on-orbit power except for the load of the instrument being powered on, the spacecraft **shall** control the instrument survival heater power turn-on step load voltage transient at the instrument survival heater power input connector to levels and duration's within the voltage transient envelope defined in the Envelope of Instrument Survival Heater Power Turn-on Voltage Transients Figure.



GIRD362	3.2.3.2.3.1-3	The spacecraft **shall** limit the duration of the instrument survival heater power turn-on voltage transient at the spacecraft's instrument survival heater

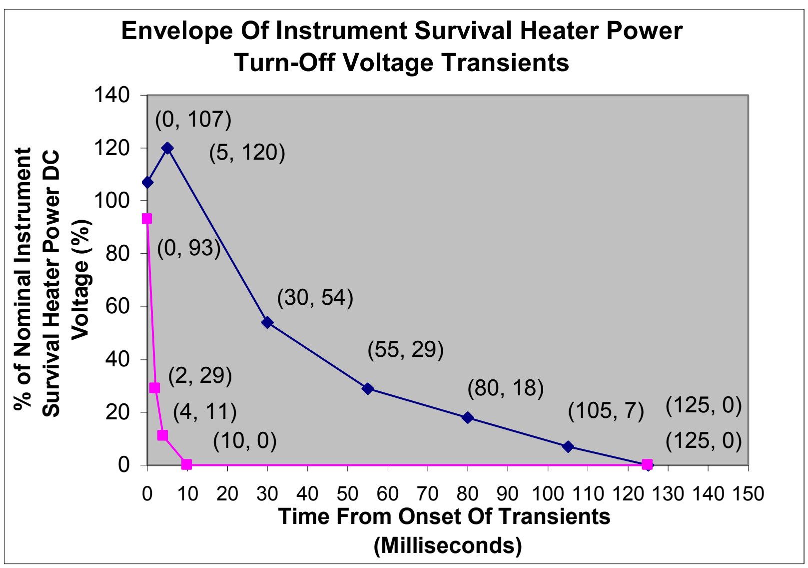
power connector of the spacecraft's instrument survival heater power unit(s) to 5 milliseconds.

GIRD363 3.2.3.2.3.1-4 The instrument **shall** meet the instrument performance specification after exposure to the instrument survival heater power turn-on voltage transients defined in **GIRD361**.

3.2.3.2.3.2 Instrument Survival Heater Power Turn-Off Step Load Voltage Transient

GIRD365 3.2.3.2.3.2-1 The spacecraft **shall** control the instrument survival heater power turn-off step load voltage transient at the spacecraft's instrument survival heater power connector of the spacecraft's instrument survival heater power unit(s) to less than or equal to 2 V above the measured steady state dc voltage.

GIRD366 3.2.3.2.3.2-2 When the spacecraft instrument survival heater power bus is drawing its maximum steady state on-orbit power, the spacecraft **shall** control the instrument survival heater power turn-off step load voltage transient at the instrument survival heater power input connector to levels and duration's within the voltage transient envelope defined in the Envelope of Instrument Survival Heater Power Turn-off Voltage Transients Figure.

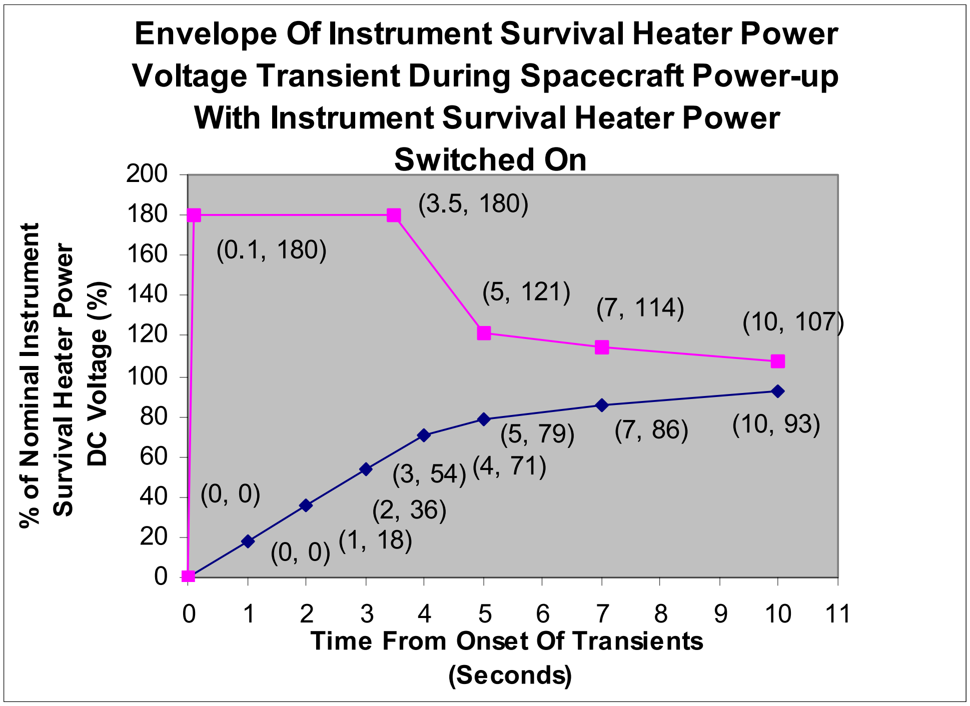


GIRD367 3.2.3.2.3.2-3 The spacecraft **shall** limit the duration of the instrument survival heater power turn-off voltage at the spacecraft's instrument survival heater power connector of the spacecraft's instrument survival heater power unit(s) to 5 milliseconds.

GIRD368 3.2.3.2.3.2-4 The instrument **shall** meet the instrument performance specification after exposure to the instrument survival heater power turn-off voltage transients defined in **GIRD366**.

3.2.3.2.3.3 Instrument Survival Heater Power Start-up Voltage Transient

GIRD370 3.2.3.2.3.3-1 During a spacecraft power-up with the instrument survival heater power switched on, the spacecraft **shall** control the voltage transient at the instrument survival heater power input connector to levels and duration's within the voltage transient envelope defined in the Envelope of Instrument Survival Heater Power Voltage Transient During Spacecraft Power-up with Instrument Operational Power Switched on Figure.



GIRD371 3.2.3.2.3.3-2 The instrument **shall** meet the instrument performance specification after exposure to the instrument survival heater power start-up voltage transients defined in **GIRD370**.

3.2.3.2.3.4 Instrument Survival Heater Power Bus Short-to-Ground Voltage Transient

GIRD373 3.2.3.2.3.4-1 During an instrument survival heater power bus short-to-ground with the instrument survival heater power bus drawing its maximum steady-state on-orbit load, the spacecraft **shall** control the instrument survival heater power bus short to ground voltage transient to levels and duration's within the voltage transient envelopes defined in the Survival Heater Transient Decay Figure, the Survival Heater Zero Voltage Duration Figure, and the Survival Heater Short to Ground Ramp-up Figure.

GIRD374 3.2.3.2.3.4-2 The instrument **shall** meet the instrument performance specification after exposure to the instrument survival heater power bus short-to-ground voltage transients defined in GIRD373.

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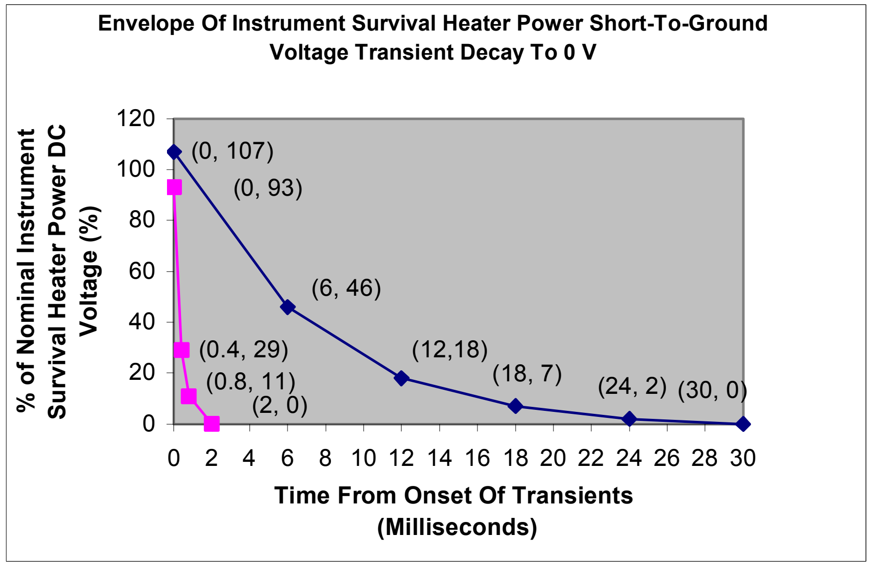
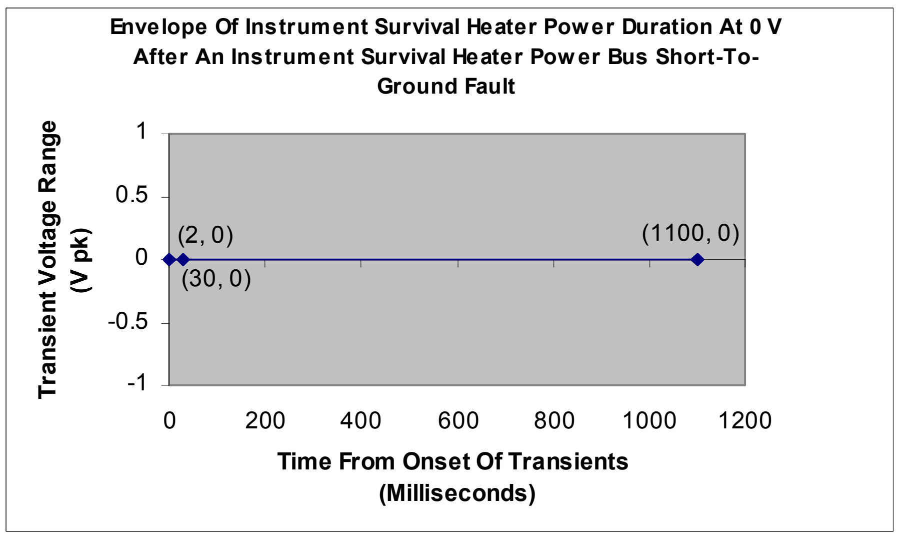
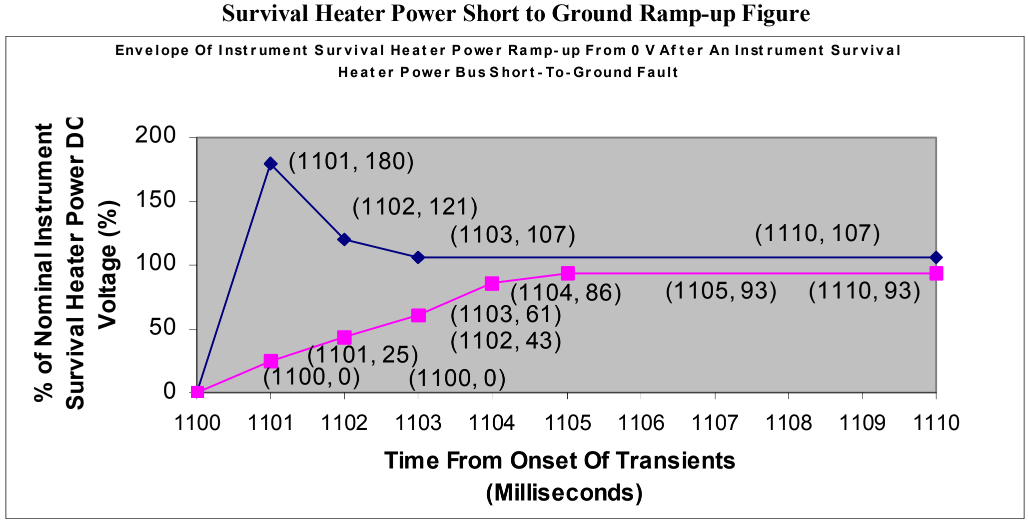
Survival Heater Power Transient Decay Figure



Survival Heater Power Zero Voltage Duration Figure



Survival Heater Power Short to Ground Ramp-up Figure



3.2.3.2.3.5 Instrument Survival Heater Power Overvoltage Fault Transient

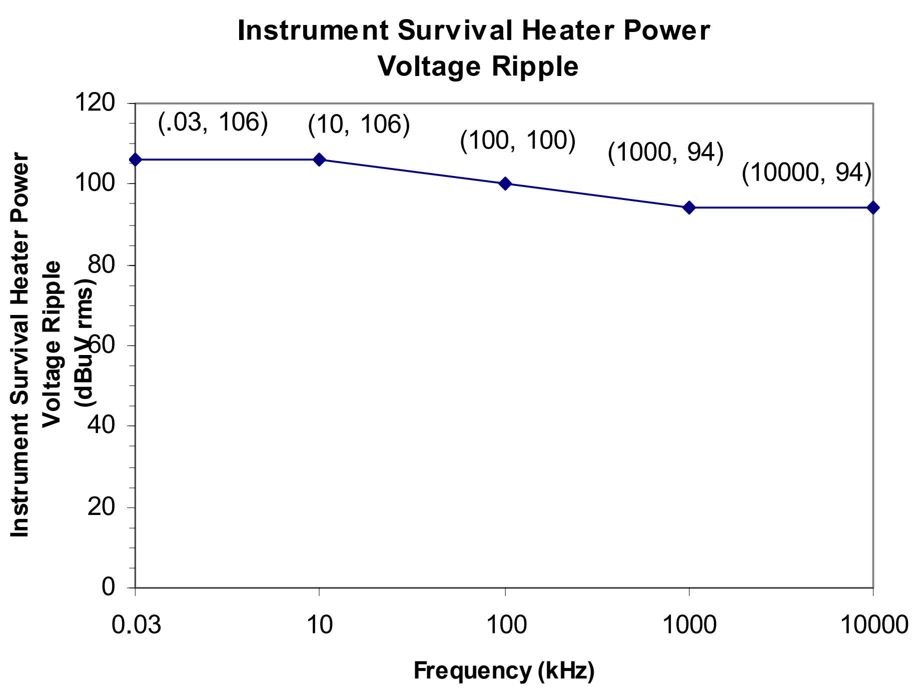
GIRD376 3.2.3.2.3.5-1 The spacecraft **shall** control the instrument survival heater power overvoltage fault transient at the instrument survival heater power input connector to less than 115% of the maximum instrument survival heater power dc voltage specified in GIRD357.

GIRD377 3.2.3.2.3.5-2 The spacecraft **shall** recover the instrument survival heater power to the steady-state instrument survival heater power dc voltage defined in **GIRD357** within 300 milliseconds of an instrument survival heater power overvoltage fault.

GIRD378 3.2.3.2.3.5-3 The instrument **shall** meet the instrument performance specification after exposure to the instrument survival heater overvoltage fault transient defined in **GIRD376**.

3.2.3.2.4 Instrument Survival Heater Power Voltage Ripple

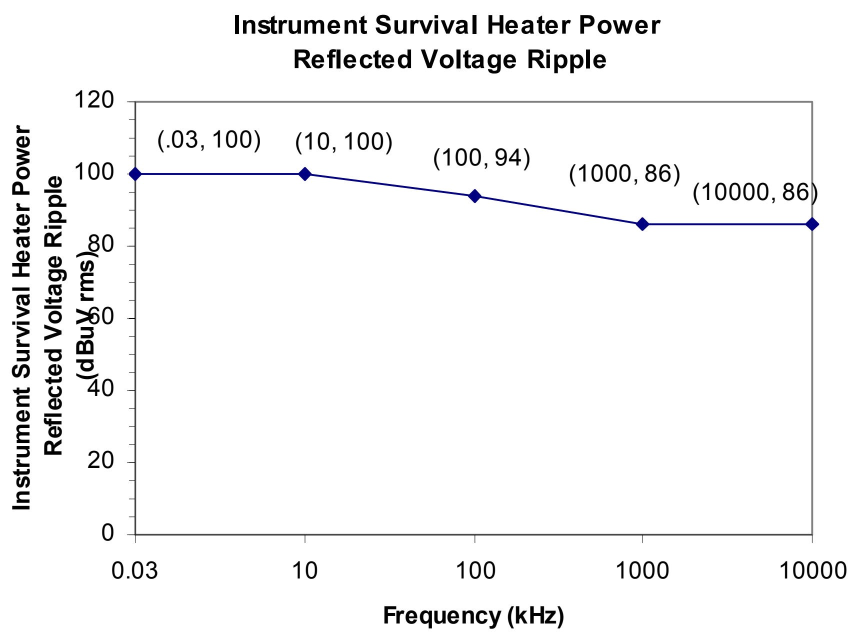
GIRD380 3.2.3.2.4-1 The spacecraft **shall** control the instrument survival heater power voltage ripple supplied at the instrument survival heater power input connector to levels that are at or within those levels specified in the Instrument Survival Heater Power Voltage Ripple Figure for all operating modes with all spacecraft power system buses loaded at their maximum steady-state on-orbit load.



GIRD381 3.2.3.2.4-2 Test measurements **shall** be in accordance with MIL-STD-461 E.

GIRD382 3.2.3.2.4-3 The instrument **shall** meet the instrument performance specification after exposure to the spacecraft-supplied instrument survival heater power voltage ripple at the instrument survival heater power input connector that is at or within the levels defined in **GIRD380**.

GIRD383 3.2.3.2.4-4 The instrument **shall** control its reflected ripple onto the instrument survival heater power bus for all operating modes when it is drawing its maximum steady-state on-orbit power to levels that are at or within those levels defined in the Instrument Survival Heater Power Reflected Voltage Ripple Figure.



GIRD390 3.2.3.2.4-5 Test measurements **shall** be in accordance with <u>MIL-STD-461 E</u>.

3.2.3.2.5 Instrument Survival Heater Power Consumption

GIRD385 3.2.3.2.5-1 The spacecraft **shall** satisfy the instrument survival heater power requirements defined in the UIID.

GIRD386 3.2.3.2.5-2 The instrument **shall** draw no more than the instrument survival heater power consumption's defined in the UIID.

3.2.3.2.6 Instrument Survival Heater Power Current Transients

3.2.3.2.6.1 Instrument Survival Heater Power Turn-On Current Transient

GIRD392 3.2.3.2.6.1-1 The instrument **shall** limit its instrument Survival Heater power turn-on current transient to no more than TBD A peak with a ramp-up rate less than 2A/microsecond.

GIRD930 3.2.3.2.6.1-2 The instrument **shall** control the instrument survival heater power turn-on current transient(s) within 125% of the maximum steady-state current draw within 20 milliseconds.

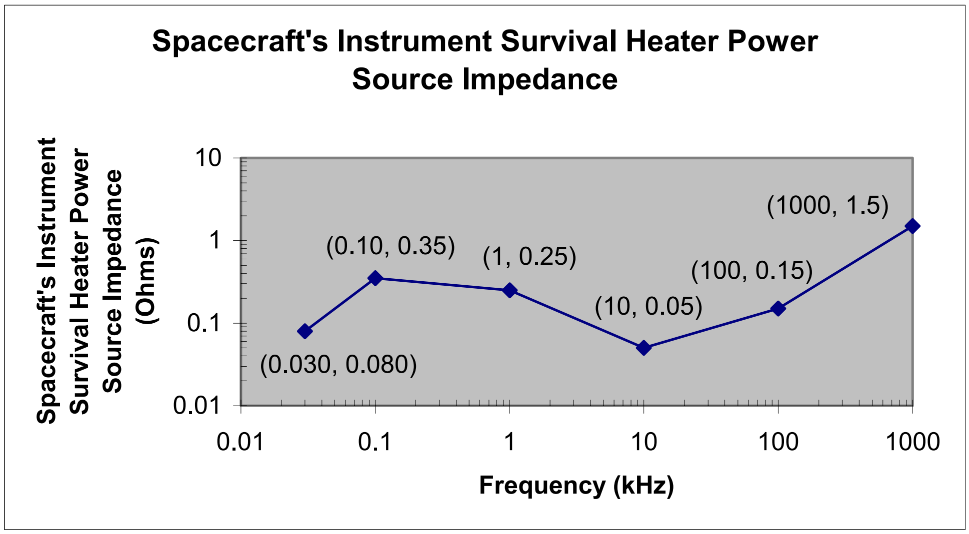
3.2.3.2.6.2 Instrument Survival Heater Power Turn-Off Current Transient

GIRD394 3.2.3.2.6.2-1 The instrument **shall** limit its instrument survival heater power turn-off current transient to no more than TBD A peak.

3.2.3.2.7 Instrument Survival Heater Power Impedance

3.2.3.2.7.1 Spacecraft's Instrument Survival Heater Power Source Impedance

GIRD397 3.2.3.2.7.1-1 The spacecraft **shall** control its instrument survival heater power source impedance within those levels specified in the Spacecraft's Instrument Survival Heater Power Source Impedance Figure.

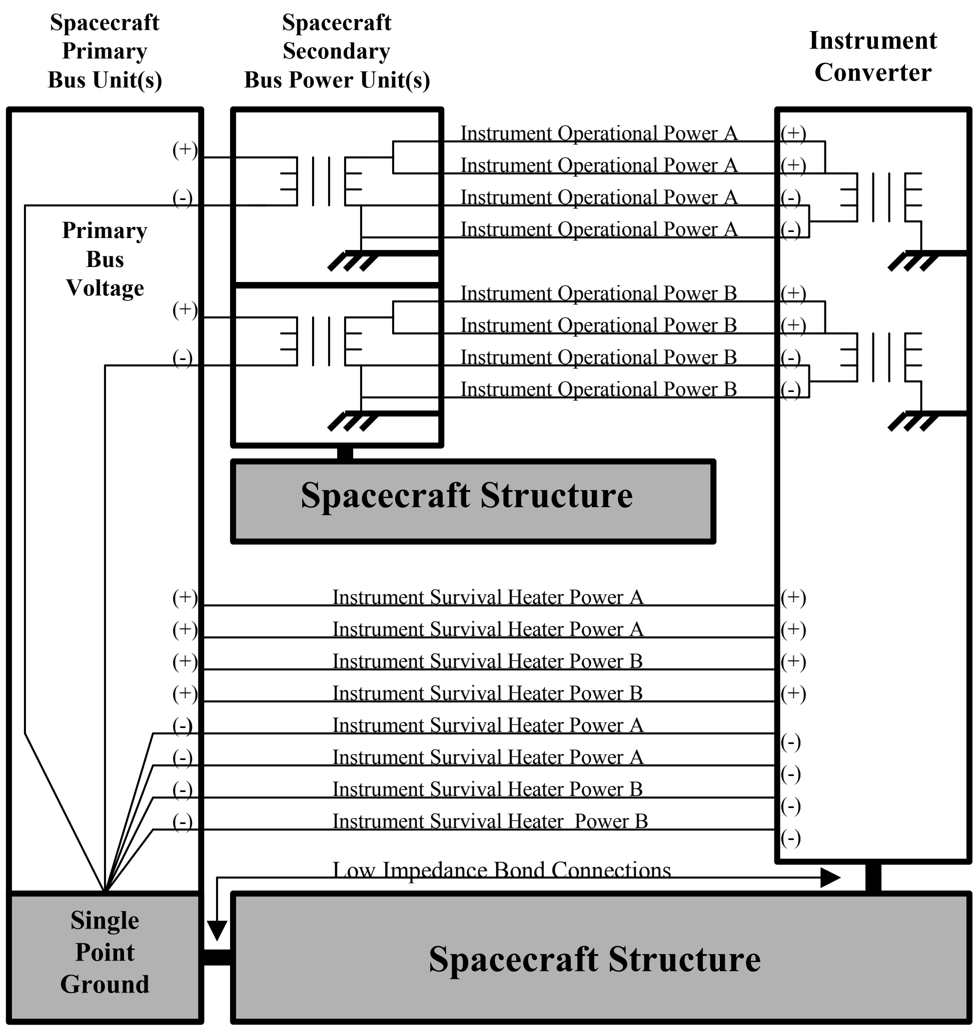


3.2.4 Instrument Electrical Power Grounding

3.2.4.1 Instrument Operational Power Grounding

GIRD402 3.2.4.1-1 The instrument electrical power grounding **shall** be in accordance with the Electrical Grounding Figure.

Electrical Grounding Figure



GIRD403	3.2.4.1-2	The spacecraft **shall** connect each instrument operational power return to the chassis of the spacecraft secondary bus power unit.
GIRD947	3.2.4.1-3	The spacecraft **shall** connect the spacecraft primary bus return(s) to the spacecraft single point ground.
GIRD1058	3.2.4.1-4	The spacecraft **shall** control the dc resistance of each primary bus return

		connection to the single point ground to less than 2.5 milliohm.
GIRD404	3.2.4.1-5	The spacecraft **shall** control the dc resistance between the spacecraft secondary bus power unit chassis and the spacecraft structure to less than 2.5 milliohm.
GIRD972	3.2.4.1-6	The spacecraft **shall** supply a low impedance bond connection with a dc resistance of less than 2.5 milliohms between the spacecraft secondary power unit chassis mounted directly to the spacecraft structure.
GIRD405	3.2.4.1-7	The instrument **shall** isolate the instrument operational power returns from the instrument chassis with a dc resistance greater than 1 megohm.

3.2.4.2 Instrument Survival Heater Power Grounding

GIRD411	3.2.4.2-1	The spacecraft **shall** connect each instrument survival heater power return on the instrument connector to the spacecraft primary bus return with a dc resistance of less than 25 milliohm.
GIRD412	3.2.4.2-2	The spacecraft **shall** connect each primary bus return to the single point ground with a dc resistance of less than 2.5 milliohm for each connector.
GIRD948	3.2.4.2-3	The spacecraft **shall** supply a low impedance bond connection with a dc resistance of less than 2.5 milliohm between the single point ground and the spacecraft structure.
GIRD413	3.2.4.2-4	The instrument **shall** isolate the instrument survival heater power returns from the instrument chassis with a dc resistance greater than 1 megohm.

3.2.4.3 Instrument Secondary Power Grounding

GIRD415	3.2.4.3-1	The instrument **shall** isolate the instrument secondary power returns from the instrument operational power and instrument survival heater power returns with a dc resistance greater than 1 megohm.
GIRD416	3.2.4.3-2	The spacecraft **shall** supply a low impedance bond connection with a dc resistance of less than 2.5 milliohm between the spacecraft structure and instrument chassis mounted directly to the spacecraft structure.
GIRD417	3.2.4.3-3	The spacecraft **shall** supply a low impedance electrical connection with a dc resistance of 2.5 milliohm between the spacecraft structure and instrument chassis mounted on other surfaces than the spacecraft structure.

3.2.4.4 Instrument Electrical Signal Grounding

3.2.4.4.1 Instrument Command Grounding

3.2.4.4.1.1 Instrument Pulse Command Grounding

GIRD952	3.2.4.4.1.1-1	The instrument **shall** isolate the instrument pulse command returns from the instrument operational power returns, instrument survival heater power returns, instrument secondary power returns and instrument serial command returns with a dc resistance greater than 1 megohm.

3.2.4.4.1.2 Instrument Serial Command Grounding

GIRD955	3.2.4.4.1.2-1	The instrument **shall** isolate the instrument serial command returns in

accordance with the European Cooperation For Space Standardization (ECSS) ECSS-E50-12A (Space Wire) standard.

3.2.4.4.1.3 Instrument Electro-Explosive Device (EED) Command Grounding

GIRD957 3.2.4.4.1.3-1 The instrument **shall** isolate the instrument EED command returns from the instrument pulse command returns, instrument serial command returns, and instrument secondary power returns with a dc resistance greater than 1 megohm.

3.2.4.4.2 Instrument Telemetry Grounding

3.2.4.4.2.1 Instrument Analog Telemetry Grounding

GIRD960 3.2.4.4.2.1-1 The instrument **shall** isolate low frequency analog telemetry returns with signal frequency characteristics below 1 MHz from the instrument operational power returns, instrument survival heater power returns, instrument pulse command returns, instrument serial command returns, instrument EED command returns, and serial telemetry returns with a dc resistance greater than 1 megohm.

3.2.4.4.2.2 Instrument Serial Telemetry Grounding

GIRD962 3.2.4.4.2.2-1 The instrument **shall** isolate the serial telemetry returns in accordance with the European Cooperation For Space Standardization (ECSS) ECSS-E50-12A (Space Wire) standard.

3.2.4.5 Instrument Electrical Accommodations

3.2.4.5.1 Spacecraft/Instrument Interface Harnessing

GIRD965 3.2.4.5.1-1 The spacecraft **shall** supply the required flight harnesses between the instrument and spacecraft. The harness is considered to include the required harness interface connectors, harness wire, harness shielding, insulation wrap, fixing plates, grommets, edge protectors, connector savers, and thermal insulation to make a reliable electrical connection for the entire mission life.

3.2.4.5.2 Spacecraft/Instrument Power Interface Harnessing

GIRD968 3.2.4.5.2-1 The spacecraft **shall** utilize harness shielding, harness twisting, and magnetic cancellation techniques to meet the electromagnetic compatibility requirements defined in **GIRD934**.

3.2.4.5.3 Spacecraft/Instrument Telemetry & Command Interface Harnessing

GIRD970 3.2.4.5.3-1 The spacecraft **shall** construct spacecraft/instrument telemetry & command interface harnesses which comply with the European Cooperation For Space

Standardization (ECSS) ECSS-E50-12A (Space Wire) standard.

GIRD971 3.2.4.5.3-2 The instrument **shall** supply the mating connectors to the spacecraft/instrument telemetry & command interface harnesses which comply with the European Cooperation For Space Standardization (ECSS) ECSS-E50-12A (Space Wire) standard.

3.2.5 Command and Data Handling

3.2.5.1 Data Transfer Between the Instrument and Spacecraft

GIRD423 3.2.5.1-1 All data transferred between the instrument and spacecraft **shall** use the European Cooperation For Space Standardization (ECSS) ECSS-E50-12A (Space Wire) standard.

3.2.5.2 SpaceWire Layer Support

GIRD425 3.2.5.2-1 All data transferred between the instrument and the spacecraft **shall** use the European Cooperation For Space Standardization (ECSS) ECSS-E50-12A (Space Wire) standard through the packet layer as a minimum.

3.2.5.2.1 Guaranteed Delivery

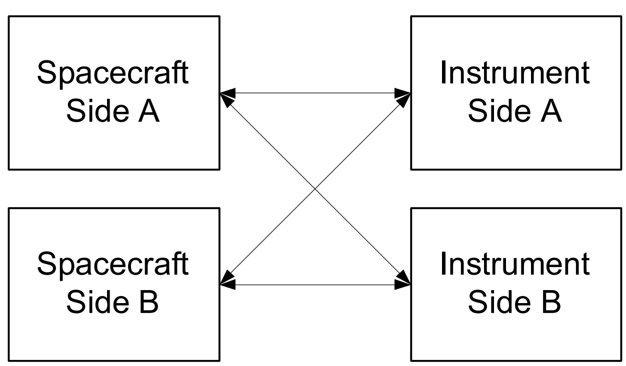
GIRD933 3.2.5.2.1-1 All data transferred between the instrument and the spacecraft **shall** provide guaranteed data delivery as defined in GOES R Space Wire Transport Protocol.

3.2.5.3 SpaceWire Data Bus

GIRD427 3.2.5.3-1 The SpaceWire Data Bus **shall** be a point-to point communications path.

3.2.5.3.1 SpaceWire Redundancy

GIRD978 3.2.5.3.1-1 The SpaceWire bus **shall** be dual redundant cross-strapped between the instrument and spacecraft as shown in the illustration below.



3.2.5.4 Source Packet Format

GIRD429 3.2.5.4-1 All data transferred over the SpaceWire **shall** use the CCSDS 701.0-B-3 Section 3.3. Source Packet definition shown in the Source Packet Definition Figure.

Source Packet Definition Figure

PRIMARY HEADER							SECONDARY HEADER	DATA VARIABLE
PACKET IDENTIFICATION				PACKET SEQUENCE CONTROL				
VERSION NUMBER	TYPE	SEC. HDR FLAG	APPLICATION PROCESS ID	SEQUENCE FLAGS	PACKET SEQUENCE COUNT	PACKET LENGTH	TIME CODE AND ANCILLARY DATA	
3 bits	1 bit	1 bit	11 bits	2 bits	14 bits	16 bits	104 bits	
							13 – 8K octets	

3.2.5.4.1 Source Packet Length

GIRD431 3.2.5.4.1-1 Source packets **shall** be variable length with a maximum data zone of 8192 octets including Secondary Header.

3.2.5.4.2 Secondary Header Flag

GIRD433 3.2.5.4.2-1 The Secondary Header Flag **shall** be set to set to the value 1.

3.2.5.4.3 Source Packet Secondary Header

GIRD435 3.2.5.4.3-1 The Source Packet Secondary Header **shall** be as defined in the Secondary Header Figure.

Secondary Header Figure

SECONDARY HEADER	
TIME CODE	**USER FLAGS**
72 bits	**32 bits**

3.2.5.4.4 Sequence Flags

GIR437 3.2.5.4.4-1 The Sequence Flags **shall** be set to the value of 11.
Note: Segmentation services are not permitted.

3.2.5.4.5 User Defined Flags

3.2.5.4.5-1 The instrument contractor will define Secondary Header User-Defined Flags in the ICD.

3.2.5.5 SpaceWire Data Rate

GIRD441 3.2.5.5-1 Data transferred over the SpaceWire data bus **shall** be clocked at 125Mhz.

Note: This clock rate allows for a 100Mbps data rate accounting for SpaceWire overhead.

3.2.5.6 Instrument to Spacecraft Data Volume

GIRD443 3.2.5.6-1 The volume of instrument data transmitted to the spacecraft **shall** not exceed the values allocated by the UIID.

3.2.5.7 Pulse Per Second (PPS)

GIRD445 3.2.5.7-1 The spacecraft **shall** provide the instrument a 1 PPS time code sequence accurate to ±10 microseconds relative to UTC.

3.2.5.7.1 SpaceWire Time Code Support

GIRD447 3.2.5.7.1-1 The 1 PPS time code sequence **shall** comply with the <u>European Cooperation For Space Standardization (ECSS) ECSS-E50-12A (Space Wire) standard.</u>

3.2.5.7.2 PPS Signal Drift

GIRD449 3.2.5.7.2-1 The 1 PPS signal **shall** not drift more than ± 1µsec over 100 seconds.

3.2.5.7.3 Time Message

GIRD451 3.2.5.7.3-1 The spacecraft **shall** transmit a source packet containing the time code to be synchronized by the 1 PPS sequence.

3.2.5.7.4 Time Code Format

GIRD453 3.2.5.7.4-1 The time code **shall** comply with the <u>CCSDS 301.B-3 Time Code Formats,</u> Day Segmented format in the Time Code Format Figure.

Time Code Format Figure

T-Field					P-Field		
Bit 0 Extension Flag ‘0’	Bits 1-3 Timecode ID ‘100’	Bit 4 Epoch 1/1/2000 ‘1’	Bit 5 Day Seg. Length ‘1’	Bits 6-7 Submsec. Length ‘01’	Day 24 bits	Msec of Day 32 bits	Microseconds 16 bits

Note: The T-Field is implied and not included in the actual time message.

3.2.5.7.5 Epoch

GIRD455 3.2.5.7.5-1 The time code epoch **shall** be January 1, 2000.

3.2.5.7.6 Distribution Timing

GIRD457 3.2.5.7.6-1 The time message **shall** be issued between 500 ms and 800 ms before reception of the SpaceWire time code sequence.

		3.2.5.8 Ancillary Data
GIRD459	3.2.5.8-1	The spacecraft **shall** provide the instruments an ancillary data packet defined in the ICD.
		3.2.5.8.1 Ancillary Packet Rate
GIRD461	3.2.5.8.1-1	The Ancillary Packet **shall** be transmitted at 100 packets per second.
		3.2.5.9 Control and Monitoring
GIRD463	3.2.5.9-1	All critical telemetry and control services **shall** be provided by the spacecraft's Remote Interface Unit (RIU). Critical telemetry is defined as telemetry points that are required to monitor the instrument in powered off state. Non-critical telemetry is defined as telemetry points that are required to monitor the instrument in powered on state. Engineering telemetry are data required to process instrument sensor data to higher level products. Housekeeping telemetry are data required to monitor instrument operation, health, and safety.
		3.2.5.9.1 Critical Telemetry
	3.2.5.9.1-1	All temperature and status telemetry required to monitor the health of the instrument will be defined in the ICD.
		3.2.5.9.2 Critical Telemetry Analog Signals
GIRD470	3.2.5.9.2-1	The spacecraft **shall** provide up to 16 analog signals to monitor critical temperature points to each instrument.
		3.2.5.9.3 Critical Telemetry Analog Signal Resolution
GIRD472	3.2.5.9.3-1	The Critical Telemetry Analog signal resolution **shall** be 12 bits ± 0.5 LSB.
		3.2.5.9.4 Discrete Control Signals
GIRD474	3.2.5.9.4-1	The spacecraft **shall** provide up to 16 discrete pulse control signals to the instrument.
		3.2.5.9.5 Discrete Monitor Signals
GIRD920	3.2.5.9.5-1	The spacecraft **shall** provide up to 16 discrete instrument monitor lines to each instrument.
		3.2.5.9.6 Critical Telemetry Signal Characteristics
GIRD982	3.2.5.9.6-1	Critical telemetry sensors **shall** be sourced, from the spacecraft a current from 0.1 to 10ma programmable in 0.1ma steps.
		3.2.5.9.7 Discrete Control Signal Characteristics
GIRD984	3.2.5.9.7-1	The spacecraft provided discrete pulse command ON signal **shall** source

500ma maximum at 28V +/- 3V with 150 msec pulse widths.

3.2.5.9.8 Discrete Monitor Signal Sink Current

GIRD986 3.2.5.9.8-1 Discrete telemetry points monitored by the spacecraft **shall** sink 1ma +/-1%.

3.2.5.9.9 Discrete Monitor ON Status

GIRD988 3.2.5.9.9-1 A Telemetry Discrete Monitor point with a current of 0.8ma or greater **shall** be considered in the ON state.

3.2.5.9.10 Discrete Monitor OFF Status

GIRD990 3.2.5.9.10-1 A Telemetry Discrete Monitor point with a current of 0.2ma or less **shall** be considered in the OFF state.

3.2.5.9.11 Instrument Configuration Commands

GIRD492 3.2.5.9.11-1 The instrument **shall** be configurable by spacecraft issued commands. Note: The instrument may also internally configure itself, reporting its configuration via telemetry.

3.2.5.9.11.1 Configuration Command Definition

3.2.5.9.11.1-1 The instrument contractor will document instrument configuration commands in the IDD.

3.2.5.9.12 Stored Command Processing

GIRD980 3.2.5.9.12-1 All stored command processing services **shall** be provided by the spacecraft.

3.2.6 Environmental Conditions

3.2.6.1 On-Orbit Radiation Environment

GIRD935 3.2.6.1-1 The instruments **shall** comply with the on-orbit radiation requirements that are described in the GSFC document <u>417-R-RPT-0027 titled "The Radiation Environment for Electronic Devices on the GOES-R Series Satellites."</u>

3.2.6.2 Launch Environment

GIRD577 3.2.6.2-1 The instrument **shall** be designed to meet the launch environment described herein. The baseline launch vehicle is planned to be an expendable Delta IV or Atlas V.

3.2.6.2.1 Thermal Environment During Launch

3.2.6.2.1-1 The fairing inner surface temperatures **shall** not exceed 150°C for 300 (TBR) seconds.

3.2.6.2.1-2 The fairing inner surface **shall** radiate to the instrument no more than 1240 W/m^2 to the instrument for 300 seconds.

3.2.6.2.1-3 The instantaneous free molecular heating on instrument surfaces in the velocity vector at the time of fairing separation **shall** not exceed 1135 W/m^2, 3 sigma.

3.2.6.2.1-4 The duration of free molecular heating **shall** be limited to 20 (TBR) seconds after fairing separation

3.2.6.2.2 Pressure Profile

GIRD585 3.2.6.2.2-1 The spacecraft contractor will document in the ICD the predicted launch pressure decay time history obtained from the launch vehicle contractor.

Inside the launch vehicle fairing, the pressure decays from a maximum of 110 kPa to an orbital minimum of 13 nPa over a period of 100 seconds.

3.2.6.2.2-2 The depressurization rate **shall** be less than 2.8 kPa/sec except for a maximum 5 second excursion to 6.2 kPa/sec.

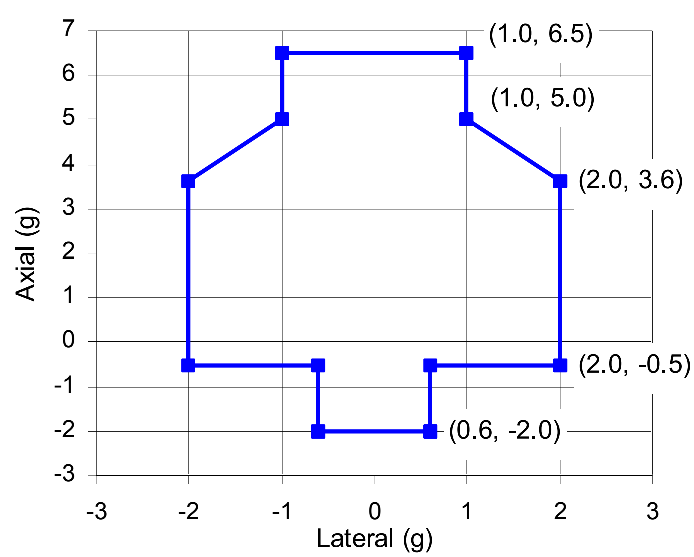
3.2.6.2.3 Flight Acceleration

GIRD588 3.2.6.2.3-1 Flight limit loads for each instrument unit **shall** be defined by the spacecraft contractor and recorded in the ICD.

GIRD589 3.2.6.2.3-2 The magnitude of the instrument unit interface forces resolved at the center of mass of the instrument units **shall** not exceed 15 times 9.81m/s/s times the instrument unit's mass.

3.2.6.2.3-3 The quasi-static acceleration limit loads for the center of mass of the spacecraft will not exceed the limits plotted in Quasi-Static Spacecraft Center of Mass Limit Loads Figure.

Quasi-Static Spacecraft Center of Mass Limit Loads Figure



3.2.6.2.4 Flight Random Vibration

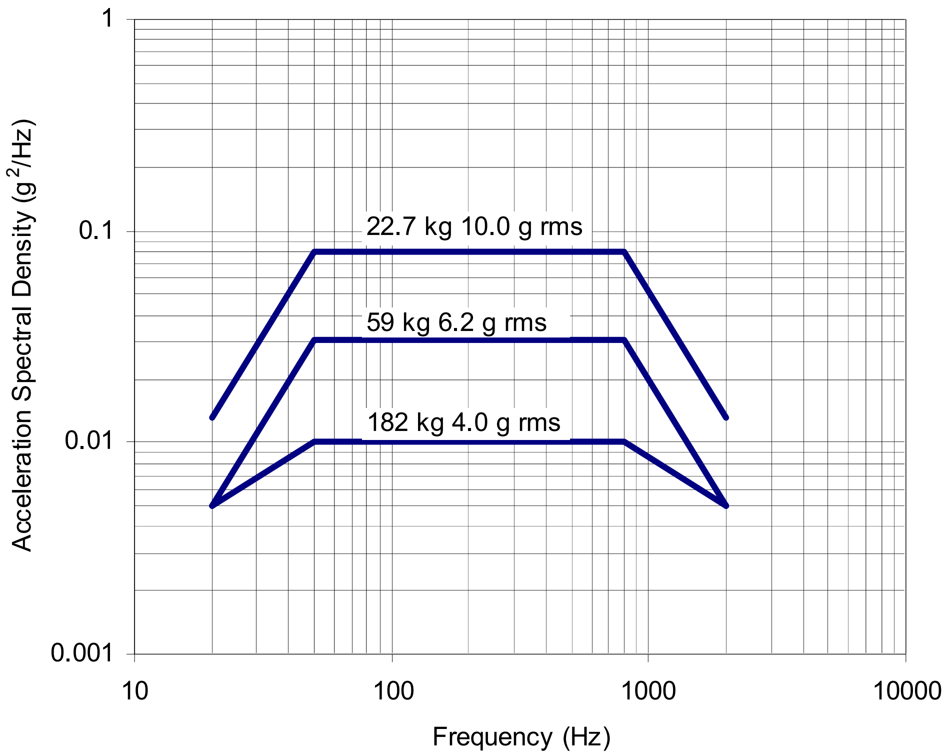
GIRD592 3.2.6.2.4-1 Based on the structural vibrations produced by the vibration and acoustic launch environments, the spacecraft contractor will document in the ICD measured or predicted maximum expected flight level random vibration environments for each of the instrument units. Flight levels are equivalent

		to acceptance levels.
GIRD874	3.2.6.2.4-2	The ASD levels **shall** not exceed the limits set in **GIRD588** and **GIRD589** Flight Acceleration.
GIRD593	3.2.6.2.4-3	The maximum expected flight random vibration Acceleration Spectral Density (ASD) for each instrument unit with a mass less than 22.7 kg **shall** not exceed the limit levels shown in the Flight Limit Acceleration Spectral Densities (ADS) figure in **GIRD596**.
GIRD594	3.2.6.2.4-4	For each instrument unit with a mass greater than 22.7 kg and less than 59 kg, the limit ASD levels **shall** be reduced by a factor of 22.7 kg divided by the mass of the unit in kilograms while maintaining the slope magnitudes at 6 dB per octave.
GIRD595	3.2.6.2.4-5	For each instrument unit with a mass greater than 59 kg and less than 182 kg, the limit ASD levels for the 50 to 800 Hz band **shall** be reduced by a factor of 22.7 kg divided by the mass of the unit in kilograms while maintaining the 20 and 2000 Hz levels at 0.005 g^2/Hz.
GIRD596	3.2.6.2.4-6	For each instrument unit with a mass greater than 182 kg, the flight ASD levels **shall** not exceed the limit ASD levels for a 182 kg unit. The Flight Limit Acceleration Spectral Densities (ASD) Figure plots the limit acceleration spectral densities for units with a mass of 22.7, 59 and 182 kg.

Flight Random Vibration Table

Frequency (Hz)	Units kg	Component Mass 22.7	59	182
20	g^2/Hz	0.013	0.005	0.005
20-50	dB/oct	+6.0	+6.0	+2.3
50-800	g^2/Hz	0.080	0.031	0.010
800-2000	dB/oct	-6.0	-6.0	-2.3
2000	g^2/Hz	0.013	0.005	0.005
Overall	g rms	10.0	6.2	4.0

Flight Limit Acceleration Spectral Densities (ASD) Figure



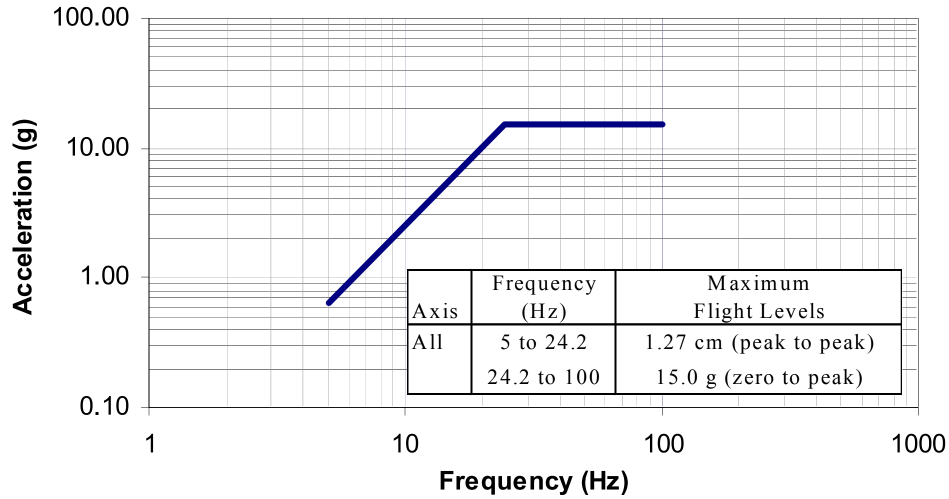
3.2.6.2.5 Flight Sinusoidal Vibration

GIRD598 3.2.6.2.5-1 Based on the structural response of the spacecraft produced by the maximum expected launch vehicle interface sinusoidal acceleration, the spacecraft contractor will document in the ICD the predicted maximum sinusoidal acceleration response at the interfaces for each of the instrument units.

GIRD599 3.2.6.2.5-2 The maximum flight sinusoidal acceleration limit loads at the interfaces for each of the instrument units **shall** not exceed the limits in the Flight Limit

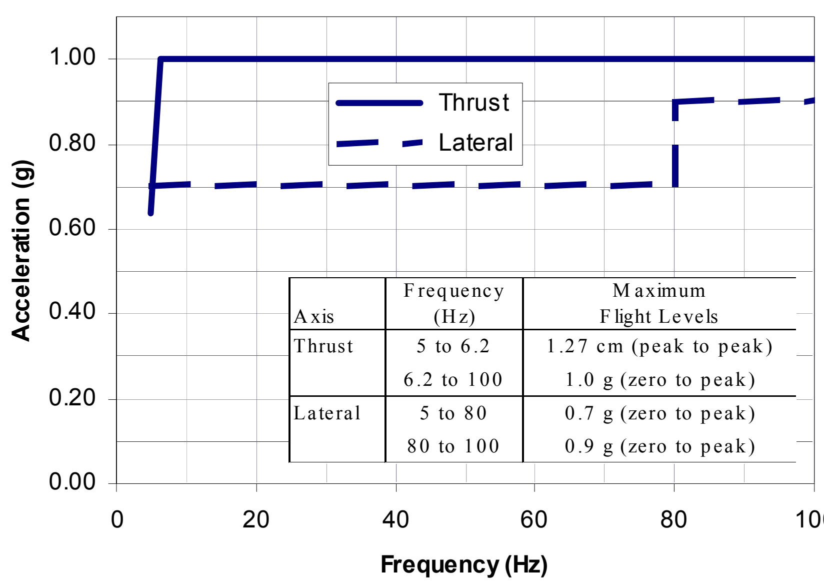
Instrument Unit Sinusoidal Accelerations Figure and the limits set in GIRD588 and GIRD589 Flight Acceleration.

Flight Limit Instrument Unit Sinusoidal Accelerations Figure



GIRD600 3.2.6.2.5-3 The maximum flight sinusoidal acceleration limit loads at the interface between the spacecraft and the launch vehicle **shall** not exceed the limits plotted in Limit Spacecraft to Launch Vehicle Sinusoidal Accelerations Figure.

Limit Spacecraft to Launch Vehicle Sinusoidal Accelerations Figure

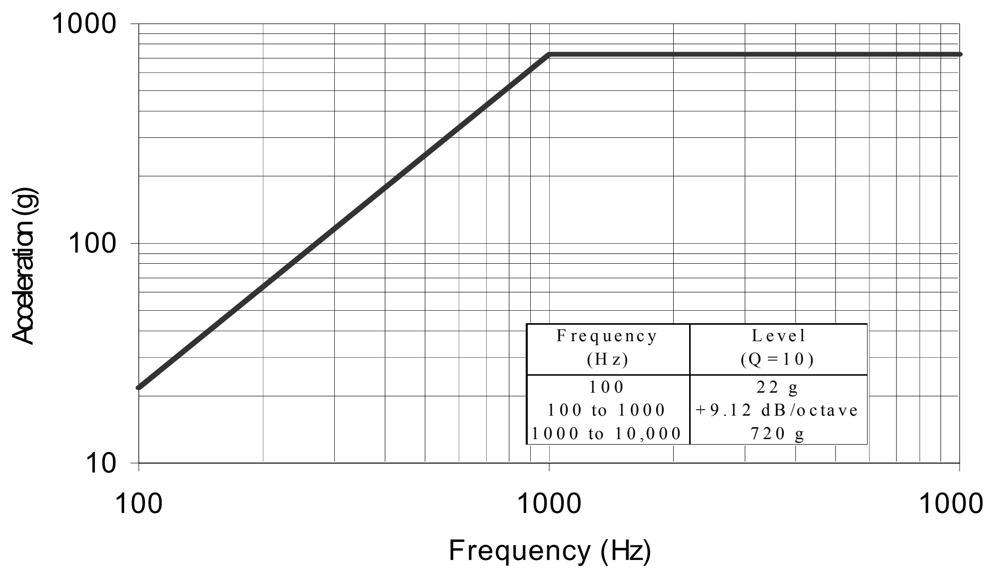


3.2.6.2.6 Shock

GIRD602 3.2.6.2.6-1 Based on launch vehicle and spacecraft shock inputs transmitted through spacecraft structure, the spacecraft contractor will document in the ICD the expected shock levels at the interfaces of the instrument units.

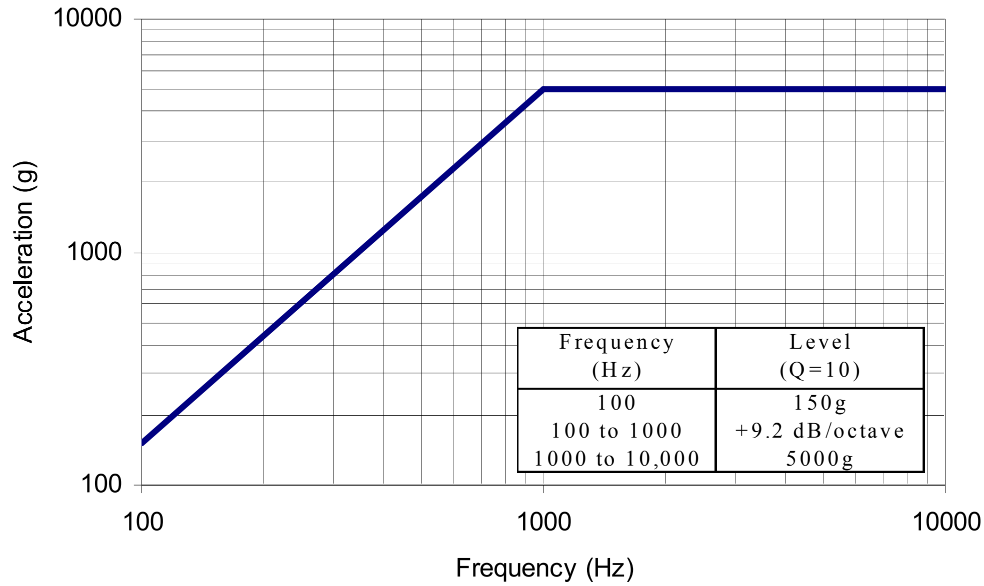
GIRD885 3.2.6.2.6-2 For each instrument unit and for each axis, the flight shock accelerations on the spacecraft side of the instrument to spacecraft interface **shall** produce a peak acceleration response spectra less than the limits set in the Flight Shock Limit Acceleration Response Spectra from the Spacecraft to Instrument Unit Figure when using a quality factor, Q, of 10.

Flight Shock Limit Acceleration Response Spectra from the Spacecraft to Instrument Unit Figure



GIRD886 3.2.6.2.6-3 The flight shock accelerations on the launch vehicle side of the interface between the spacecraft and the launch vehicle **shall** produce a peak acceleration response spectra less than the limits set in the Flight Shock Limit Acceleration Response Spectra from the Launch Vehicle to Spacecraft Figure in **GIRD919** when using a quality factor, Q, of 10.

3.2.6.2.6-4 Flight Shock Limit Acceleration Response Spectra from the Launch Vehicle to Spacecraft Figure



3.2.6.2.7 Flight Acoustics

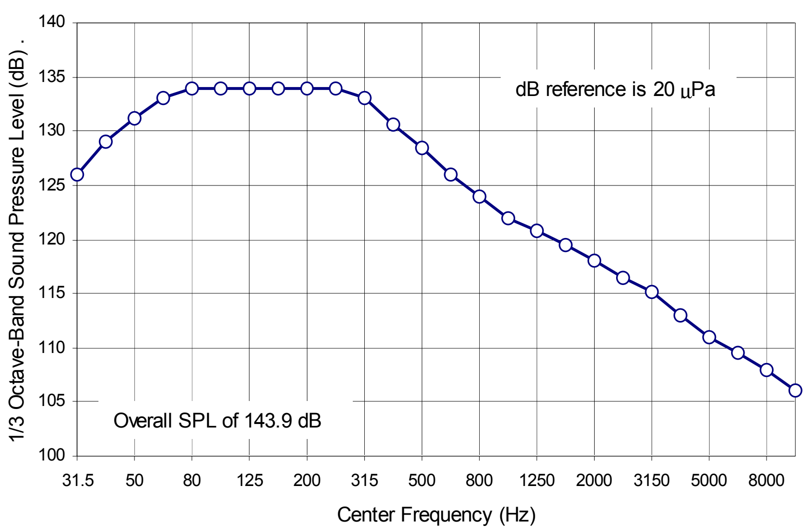
GIRD605 3.2.6.2.7-1 The spacecraft contractor will document in the ICD the predicted Maximum Expected Flight Level (MEFL) for the acoustic environment with 95 percent probability and with 50 percent confidence.

GIRD606 3.2.6.2.7-2 The MEFL with a 95th percentile and 50 percent confidence **shall** not exceed the one third octave band limit Sound Pressure Levels (SPL) listed by their center frequencies in the Flight Limit Acoustic Sound Pressure Levels Table and plotted in the Flight Limit Acoustic Sound Pressure Levels Figure.

Flight Limit Acoustic Sound Pressure Levels Table

One-third Octave Bands			
Center Frequency (Hz)	SPL* (dB)	Center Frequency (Hz)	SPL* (dB)
31.5	126.0	630	126.0
40	129.0	800	124.0
50	131.2	1000	122.0
63	133.0	1250	120.7
80	134.0	1600	119.5
100	134.0	2000	118.0
125	134.0	2500	116.5
160	134.0	3150	115.1
200	134.0	4000	113.0
250	134.0	5000	111.0
315	133.0	6300	109.6
400	130.6	8000	108.0
500	128.5	10000	106.0
*Reference pressure is 20 μPa		Overall	143.9

Flight Limit Acoustic Sound Pressure Levels Figure



3.2.6.3 On-Orbit Environment

3.2.6.3.1 Acceleration

GIRD609	3.2.6.3.1-1	Instrument flight hardware **shall** be designed to withstand a maximum acceleration of 0.040 (TBR) g on orbit without permanent degradation of performance.
		3.2.6.3.2 Orbital Heat Flux
GIRD613	3.2.6.3.2-1	The following orbital heat flux magnitudes **shall** be assumed.
		3.2.6.3.2.1 Direct Solar Flux
GIRD615	3.2.6.3.2.1-1	The maximum magnitude of direct solar flux to be used **shall** be 1414 W/m^2 ± 5 W/m^2 uncertainty occurring at earth perihelion.
GIRD616	3.2.6.3.2.1-2	The minimum magnitude of direct solar flux to be used **shall** be 1322 W/m^2 ± 5 W/m^2 uncertainty occuring at earth aphelion. Fluxes on specific daes may use a cosine inerpolation between the perihelion and aphelion.
		3.2.6.3.2.2 Non-Cryogenic Systems
	3.2.6.3.2.2-1	For non-cryogenic instruments, only solar flux needs to be considered.
		3.2.6.3.2.3 Cryogenic Systems
GIRD620	3.2.6.3.2.3-1	For cryogenic instruments, in addition to solar flux, earth reflected solar flux (albedo flux) and earth radiation **shall** be considered.
GIRD621	3.2.6.3.2.3-2	Earth reflected solar flux **shall** be modeled assuming a 0.26 albedo factor (Lambertian earth reflection assumed).
GIRD622	3.2.6.3.2.3-3	Earth IR **shall** be modeled assuming a 326 W/m^2 emitted radiance (at earth's surface), which is equivalent to a 2^O C black body earth temperature.
		3.2.6.3.2.4 Eclipse
GIRD624	3.2.6.3.2.4-1	Solar Eclipse **shall** be considered as part of the environmental variation. The Solar Eclipse season occurs twice yearly, with each eclipse season lasting approximately 45 days. The maximum eclipse duration is 72 minutes.
		3.2.6.3.2.5 Lunar Eclipse
GIRD626	3.2.6.3.2.5-1	Lunar Eclipses **shall** be considered for instrument survivability. Lunar eclipses of 105 minutes maximum duration are rare occurrences.
GIRD627	3.2.6.3.2.5-2	Lunar Eclipses **shall** not be considered as a nominal operation design case.
		3.3 Attitude and Orbit Data
GIRD 946	3.3-1	All attitude, rate and orbit data **shall** be included in the spacecraft ancillary data packet.
		3.3.1 Attitude Knowledge
GIRD631	3.3.1-1	The spacecraft **shall** provide a periodic attitude estimate to the instrument.
		3.3.1.1 Representation
GIRD633	3.3.1.1-1	The attitude estimate **shall** be a quaternion representation of the attitude of

the instrument mounting frame relative to the J2000 inertial reference frame.

3.3.1.2 Accuracy

GIRD635 3.3.1.2-1 The attitude estimate **shall** be accurate to within ±100 microradians, per axis, 3-sigma. This requirement bounds the knowledge error, which is the difference between the estimated attitude and the true attitude.

3.3.1.3 Update Rate

GIRD637 3.3.1.3-1 The spacecraft **shall** update the attitude estimate at a rate no less than 1 Hz.

3.3.1.4 Latency

GIRD639 3.3.1.4-1 The attitude estimate latency **shall** not exceed 100 milliseconds.

3.3.2 Spacecraft Angular Rate

GIRD641 3.3.2-1 The spacecraft **shall** provide a periodic angular rate estimate to the instrument.

3.3.2.1 Representation

GIRD643 3.3.2.1-1 The spacecraft angular rate data **shall** be the inertial angular rate of the spacecraft, in units of microradians per second, resolved in the instrument mounting frame defined in **GIRD1064**.

3.3.2.2 Accuracy

3.3.2.2-1 The accuracy of the spacecraft angular rate estimate is characterized by rate white noise, angle white noise, and the integral of the rate error over a specified time window. The rate error is defined as the difference between the estimated rates and the actual rates of the spacecraft. The integrated rate error includes all residual IRU errors after compensation by the spacecraft and also includes errors due to alignment knowledge error between the IRU input axes and the instrument mounting frame.

GIRD 1068 3.3.2.2-2 The rate white noise component of the spacecraft angular rate estimate **shall** not exceed a power spectral density (PSD) level of

$$\sigma_v = 0.05\,\mu rad / s^{1/2}$$

GIRD 1069 3.3.2.2-3 The angle white noise component of the spacecraft angular rate estimate **shall** not exceed a power spectral density (PSD) level of

$$\sigma_e = 0.02\,\mu rad / Hz^{1/2}$$

GIRD646 3.3.2.2-4 The integrated rate error of the spacecraft angular rate estimate **shall** not exceed ±0.6 microradians, 3-sigma, per axis, over any 1-second window.

GIRD647 3.3.2.2-5 In addition, the integrated rate error of the spacecraft angular rate estimate **shall** not exceed ±2 microradians, 3-sigma, per axis, over any 120-second window.

GIRD648 3.3.2.2-6 In addition, the integrated rate error of the spacecraft angular rate estimate **shall** not exceed ±5 microradians, 3-sigma, per axis, over any 300-second window.

		3.3.2.3 Bandwidth
GIRD650	3.3.2.3-1	The spacecraft angular rate estimate **shall** have a minus 3dB bandwidth of greater than 25 Hz.
GIRD973	3.3.2.3-2	The spacecraft angular rate estimate **shall** have a second order frequency response.
GIRD974	3.3.2.3-3	The frequency response amplitude of the spacecraft angular rate estimate **shall** be stable to less than 1% (TBR) from 0.1 to 25 Hz.
GIRD975	3.3.2.3-4	The frequency response phase of the spacecraft angular rate estimate **shall** be stable to less than 1 degree (TBR) from 0.1 to 25 Hz.
	3.3.2.3-5	The spacecraft contractor will document in the instrument ICD the gyro rate frequency response function from 0 Hz to at least ten times the -3dB gyro bandwidth .
		3.3.2.4 Update Rate
GIRD652	3.3.2.4-1	The spacecraft **shall** update the angular rate estimate at a rate no less than 100 Hz.
GIRD654	3.3.2.4-2	Spacecraft angular rate sampling **shall** be uniform to within ±20 microseconds.
		3.3.2.5 Latency
GIRD655	3.3.2.5-1	The spacecraft angular rate estimate latency **shall** not exceed 7 milliseconds.
GIRD656	3.3.2.5-2	Spacecraft angular rate latency **shall** be stable to within ±20 microseconds.
		3.3.3 Spacecraft Orbit
GIRD658	3.3.3-1	The spacecraft **shall** provide a periodic spacecraft orbit estimate to the instrument via the ancillary data packet.
		3.3.3.1 Representation
GIRD660	3.3.3.1-1	The spacecraft orbit estimate **shall** include epoch time and Cartesian position and velocity vectors.
		3.3.3.2 Accuracy
GIRD 662	3.3.3.2-1	The spacecraft position estimate **shall** be accurate to within ±300 meters (TBR), 3-sigma, in the in-track (x-axis) and cross-track (y-axis) directions, and accurate to within ±2 kilometers, 3-sigma, in the radial (z-axis) direction.
GIR 663	3.3.3.2-2	The spacecraft velocity estimate **shall** be accurate to within ±1 cm/sec , 3-sigma per axis.
		3.3.3.3 Update Rate
GIRD665	3.3.3.3-1	The spacecraft **shall** update update the orbit estimate at a rate no less than 1 Hz.
		3.3.3.4 Latency

GIRD667	3.3.3.4-1	The spacecraft orbit estimate latency **shall** not exceed 1 second.
		3.4 Instrument GSE to Spacecraft I&T GSE Interface
GIRD921	3.4-1	Instrument GSE **shall** receive instrument telemetry via the spacecraft electrical GSE.
GIRD922	3.4-2	Commanding of the instrument **shall** be from the spacecraft electrical GSE.
		3.5 Contamination Control
		3.5.1 Instrument and Spacecraft Ground Processing
		3.5.1.1 Facility Requirements
GIRD793	3.5.1.1-1	Airborne particle fallout **shall** not exceed 0.022 percent area coverage (%AC) per month in an ISO 14644 Class 7 facility.
GIRD794	3.5.1.1-2	Airborne particle fallout **shall** not exceed 0.22 %AC per month in an ISO 14644 Class 8 facility.
GIRD795	3.5.1.1-3	Airborne molecular fallout **shall** not exceed 0.30 micrograms per square centimeter ($\mu g/cm^2$) per month in a cleanroom.
GIRD796	3.5.1.1-4	Airborne Total Hydrocarbons (THC) **shall** be less than 15 Parts Per Million (PPM) (TBR).
	3.5.1.1-5	Flight hardware will be processed in an ISO 14644-1 Class 7 (TBR) cleanroom or better when contamination sensitive surfaces are exposed.
	3.5.1.1-6	The instrument will be processed in an ISO 14644-1 Class 8 (TBR) cleanroom or better when contamination sensitive surfaces are covered. Optical solar reflectors (OSRs) and solar panels are exceptions. They may be exposed in an ISO 14644-1 Class 8 cleanroom.
	3.5.1.1-7	ISO 14644-1 class conformance will be determined using airborne particle counts larger than 0.5 µm and 5.0 µm.
	3.5.1.1-8	Flight hardware will be maintained in a relative humidity environment between 30 and 60%.
		3.5.1.2 Ground Support Equipment Requirements
GIRD801	3.5.1.2-1	The items **shall** outgas less than 1×10^{-7} g/cm^2-hr (TBR) at 10 K above the maximum survival temperature of the flight hardware that they are tested with when measured with a QCM held at 208 K.
	3.5.1.2-2	Hardware used in vacuum testing will be vacuum-baked prior to use in vacuum with flight modules.
	3.5.1.2-3	The items will be baked at 10 K above the maximum survival temperature of the flight hardware that they are tested with.
		3.5.1.3 Purge Requirements
	3.5.1.3-1	The instrument contractor will provide a gas purge to the instrument optical cavity during all storage, test, and transport operations.
GIRD804	3.5.1.3-2	There **shall** be no more than 500 Parts Per Billion (PPB) Total Hydrocarbons (THC) in the purge gas.

GIRD805	3.5.1.3-3	There **shall** be no more than 1 Part Per Million (PPM) moisture in the purge gas.
GIRD806	3.5.1.3-4	There **shall** be no particles larger than 5 micrometers in the purge gas.
	3.5.1.3-5	The instrument contractor will document maximum and minimum acceptable flow rates for the purge gas.
	3.5.1.3-6	The instrument contractor will assume that the purge gas is nitrogen.

3.5.1.4 Ground Storage/Transportation Requirements

	3.5.1.4-1	During storage and transportation periods, the instrument will be bagged in ESD protective material.
GIRD814	3.5.1.4-2	The ESD protective material **shall** not transfer more than 0.02 %AC of particles during storage and transport.
GIRD815	3.5.1.4-3	The ESD protective material **shall** not transfer more 0.30 $\mu g/cm^2$ of molecular contamination during storage and transport.
	3.5.1.4-4	Witness samples representative of contamination-sensitive instrument surfaces will be examined and changed when other instrument testing is done during extended storage periods.

3.5.1.5 Pre-Launch Cleaning Access

	3.5.1.5-1	The spacecraft contractor will provide access to instrument and spacecraft contamination-sensitive surfaces at the launch site for inspection.
	3.5.1.5-2	The spacecraft contractor will provide access to instrument and spacecraft contamination-sensitive surfaces at the launch site for cleaning.

3.5.2 Mission Considerations

3.5.2.1 Design

GIRD822	3.5.2.1-1	Multi Layer Insulation (MLI) venting and spacecraft vents **shall** be directed away from instrument optical ports, instrument thermal control surfaces, and spacecraft thermal control surfaces.
GIRD823	3.5.2.1-2	All MLI joints **shall** be sealed shut prior launch, so that only the planned vent paths allow outgassed molecular species to escape. This requirement will not supersede any requirement for thermal isolation. It is meant to reduce outgassing in an unplanned direction.
GIRD824	3.5.2.1-3	All instrument and spacecraft components with a direct line of sight to the instrument optical and thermal surfaces **shall** be vacuum baked prior to thermal vacuum testing. Contamination potential is determined by analysis (see Molecular Contamination section).
GIRD825	3.5.2.1-4	All flight hardware bakeouts **shall** continue until the outgassing rate has been verified with a Quartz Crystal Microbalance (QCM) or other devices approved by NASA to meet the molecular contamination analysis BOL values.
	3.5.2.1-5	The instrument contractor will provide the location of vents in the instrument flight units for inclusion in the ICD.
	3.5.2.1-6	The instrument contractor will provide the size of vents in the instrument flight units for inclusion in the ICD.

3.5.2.1-7 The instrument contractor will provide the orientation of the vent aperture in the instrument flight units for inclusion in the ICD.

3.5.2.1-8 The instrument contractor will provide the operation time of vents in the instrument flight units for inclusion in the ICD.

3.5.2.2 Mission Performance

3.5.2.2.1 Particulate Contamination

GIRD832 3.5.2.2.1-1 Launch, ascent, and orbit raising **shall** contribute no more than 0.3% area coverage of particles to any exposed sensitive surface during launch and orbit raising.

3.5.2.2.2 Molecular Contamination

GIRD834 3.5.2.2.2-1 The spacecraft **shall** contribute no more than 6 $\mu g/cm^2$ nonvolatile residue to instrument thermal control surface apertures, and the instrument optical aperture.

3.5.2.2.2-2 The instrument contractor will use a density of 1.0 g/cm^3 for all molecular contaminants.

3.5.2.2.2-3 The instrument contractor will use a transformation value of 0.01 solar absorptance units per 100 Angstroms of NVR on fused quartz optical solar reflectors (OSRs).

GIRD837 3.5.2.2.2-4 The BOL outgassing rates from the molecular contamination analysis for instruments, spacecraft main body, MLI, and the solar array **shall** be verified using a quartz crystal microbalance. BOL outgassing is the final outgassing rate determined during system-level thermal vacuum testing at the mission high temperature, plus 10^0C.

3.6 Acronyms